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THE ASTEROID PROBLEM.*

REV. JOEL H. METCALF.

In the last twenty years the Asteroid problem has become very much the problem of the expressman in Ellis Parker Butlers classic "Pigs is Pigs." The rapid and continuous multiplication of discoveries, since the invention of the photographic method for their detection, has introduced an embarrassment of riches which makes it difficult to decide what to do with them. Formerly the discovery of a new member of the solar system was applauded as a contribution to knowledge. Lately it has been considered almost a crime.

It is like the birth of a child in an already too large family; to keep track of it and bring it up properly is too much of a strain upon the family exchequer.

In the 90 years from January 1, 1801, when Piazzi discovered Ceres, to December 1891, when Wolf picked up Brucia, 323 small planets were added to our knowledge of the solar system; in the last twenty years about 427 have been sufficiently observed to assure good orbits. And so, as the expressman had to decide whether Guinea Pigs were pigs or rabbits, so astronomical science has to determine whether it will go on with the work of discovery or drop the whole subject, as requiring a disproportionate amount of labor both for the observer and computer.

The difficulty, though accentuated in this branch of science, is fundamentally the same as that which comes with any other increased power of observation.

What are we going to do with the multitude of stars we find upon our photographic plates?

The astographic catalogue is a monumental work which will cost millions of dollars and many more years to complete. And after it is all done, in certain respects it will not be as useful as Argelander's Durchmusterung. Who is going to determine the spectral type of these stars after the positions are obtained?

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What are we going to do with the ever increasing multitude of new variable stars that Harvard Observatory and others are constantly announcing? In all these directions we seem to be making ever enlarging demands upon the labor of not only the astronomers of today but of future generations. Each increase of telescopic power increases the need of observation and discussion at a geometrical rate. And after all the Philistine will say: "What is the advantage in entering into a wholesale business anyway? When you know one star you know all stars. In what respect are a thousand black dots on a plate better than ten, or a hundred asteroids better than one?"

It must be admitted that there is a great deal of valuable time wasted in observing minor planets. All who are familiar with the pages of the *Astronomische Nachrichten* know how the paper is littered up with observations of well-known asteroids. Some observatories will pick up a bright well-known planet and follow it for weeks and sometimes months, getting an accurate position every clear night. It shows well for the industry of the observers but it is hard to see its value. At the same time the less known are not observed at all, probably because they are hard to find. With a few notable exceptions like that at Vienna, it would be well if most of the visual observations of old asteroids were given up. There is also a great opportunity for coöperation between observatories and division of labor, so that as many as possible may be observed at each opposition. This would have the effect of reducing the labor of computers and correcting the orbits, which in some cases, due to perturbations, are now in a rather bad state. Admitting all this I would like to make a few general remarks favorable to this branch of science.

It is true the photographic method has increased the rate of discovery about seven-fold. But it has also increased the power of observation in the same proportion. Whereas in the old days it would take an observer and a large equatorial practically a whole night to observe a single asteroid, with an outfit like that of Heidelberg it would not be difficult to photograph fifteen or more in a working night. Out of 324 asteroids observed in 1909,157, nearly half, were observed by the observatory at Heidelberg. Even as it is, where Professor Wolf bears the brunt of observation, the asteroids are on the whole well observed. All but sixteen of the 750 have been observed in the last ten years and the large majority of them in the last five years.

On the side of computation, now that only opposition ephemerides are published by the Rechen Institute and the precision of the computations limited to about ½° to 1° of geocentric place, which is the present policy of the Rechen Institute, correcting the elliptical positions by means of the empirical data obtained by the frequent observations, the strain of the large number of asteroids upon the computers is greatly reduced. It is the belief of Professor Cohn the new director of the Rechen Institute that, by greater coöperation and division of labor among observers, a systematic following of all the minor planets might be obtained without increase of work. In our work at the observatory at Taunton, now at Winchester, Mass., we found three times as many new asteroids as we were able to follow sufficiently to obtain good orbits. I would undertake to find a new planet on any clear winter night. Judging from our experience I should say there must be at least 1500 planets, brighter than the fourteenth magnitude at some of their oppositions, and so photographically easy of observation even with a comparatively small photographic doublet if my method of following the asteroid is used instead of that devised by Professor Wolf. To leave the work where it is would be manifestly unscientific and would be the abandonment of much good work already done. The undertaking of which this is a part is a great world problem not for the individual but for the race. It is inconceivable that the science of the future will not desire to substitute fact for theory in its answer to the question whence and whither. It is perfectly certain that no theory of the evolution of the solar system will be ultimately satisfactory which leaves out the minor planets as an important consideration, whether they are chips of natures workshop, or leftover material of the pabulum from which the major planets were formed or only straws to show us the drift of early solar forces.

In any case the science of the future, which will desire to substitute facts for speculations, will need to know the number, distribution and limits of the asteroids, before it can settle a problem which must interest man for all time. With our speculations on the origin of the solar system, an ounce of fact is worth a pound of theory. Asteroidal bodies like the small satellites of Jupiter, Saturn and Mars, have already cast a deciding vote in relation to some early theories of evolution and it is more than likely that yet undiscovered bodies will do so again in the future. As we have the planetesimal theory it would seem especially important to find out what planetesimal bodies there are in the solar system today.

The assumption of those who think the asteroid investigation is overdone is that the new discoveries will be in the class of those already known and so add numbers but not novelty. But no such assumption is rational.

Would any astronomer doubt, speaking with a full appreciation of the gigantic labors of early asteroid hunters, that the planet Eros is the justification amply repaying the 97 years of asteroid work that preceded it?

Does any one question that the four asteroids of the Jupiter group, Achilles, Patroclus, Nestor and Hector, are the justification of all the labors that have been expended since? Here we have four bodies with almost the same mean distance and motion as Jupiter, the daily motion ranging from 292″ to 300″ while that of Jupiter is 299″. Some of these bodies represent Lagranges theorem that three bodies, no matter what their size, will form a stable system if they are at the points of an equilateral triangle from one another. But these positions do not represent all of these bodies. Nor according to Professor Brown is any such position required. They thus represent the problem of these bodies in a form where the future motions of these bodies will test all the theory mathematical astronomers care to give to them.

Now that four of these bodies are already known the probability is that there are many more as yet undiscovered. For the purposes of statistical investigation of the distribution of asteroids, especially to test the existence of gaps in the series, due to a synchronism between their motion and that of Jupiter, we need to know the orbits of our 1500, half of which are yet undiscovered. Neither can one tell when he discovers an asteroid whether it is interesting or not till its orbit is computed.

When we turn to the side of our hopes in the yet undiscovered there is not the slightest reason for skepticism. The remarkable asteroid 1911 MT, discovered by Palisa of Vienna, is a case in point. Its loss is little short of an astronomical tragedy.

Here was an object, apparently an asteroid, which was moving at the opposition point nearly two minutes east and half a degree south per day. No known planet, even Eros, could do this. Its proximity to the earth and its earthward motion was so great that the motion of the earth was not sufficient to make it seem to retrograde. In fact it moved eastward in angular distance more than half the motion of the earth. Owing to the Full Moon, bad weather and some mistake in not telegraphing it to America, it was only observed three times on

two days; not sufficient to get even a vague orbit but enough to show that it was either an asteroid with a mean distance less than that of Eros or perhaps an asteroid with a cometary orbit which might even be parabolic. No matter what it was, it was an object we could ill afford to lose and a proof positive of the existence of bodies of such novelty that the hope of discovering some such encourages asteroid observers to continue their labors. What a pity indeed if a better Eros has slipped through our fingers, but how encouraging to think that such objects are really awaiting discovery as America waited for Columbus! It might be assumed that the probability of discovering such novel and valuable objects is growing very slight as the years go by and they are not found. A little thought on the subject will remove this objection.

The great mass of the work on asteroids is done by one observatory in a high northerly latitude. This makes the fall and winter the only time when it can work to advantage. The ecliptic for nearly six months of its extent is practically unobserved. Objects of great eccentricity are not liable to be found except when their opposition comes near perihelion. The chances of finding them at any one opposition are comparatively slight, for they would usually be very faint. If their perihelion came in the longitude which is in opposition in the spring and summer, they would be likely to escape detection or thrown out as uninteresting. Occlo is a good illustration. When discovered it looked as though it might be a second Eros on account of its great southern declination and rapid motion. It proved to be the most eccentric of all the known asteroids, with a perihelion which comes in opposition in the summer time. If therefore it had not been picked up more or less by accident at Arequipa, it would yet be unknown, for at none of its northerly oppositions has it been brighter than the fourteenth magnitude. Another reason the chances are still favorable for a better Eros is because under present conditions they are not likely to be observed unless their opposition comes when they are very near the node. At any other time their close approach to the earth would make them describe a very large loop either north or south of the ecliptic; at times going nearly to the pole. Under present conditions, as the region of the ecliptic is the only place which is well observed, such bodies would be almost sure to escape observation for a long time.

On the whole I conclude that the chances for more interesting and valuable discoveries by the photographic method were

never better than now. The value of planets does not depend wholly on their size and there is no apriori reason why bodies sufficiently large to be observable may not be discovered far beyond the orbit of Jupiter and much nearer than Eros.

In fact it is a pity some systematic work has not been done to find asteroidal bodies interior to the earth. The zodiacal light seems to be a beckoning hand in this direction. With the instrumental means at our disposal today and the methods now in use we have a drag net with fine enough meshes to catch some very small celestial fishes and, although it may be true that the larger ones are all caught, there is no reason why we may not apply the old proverb and say there are better fish in that unsounded sea than have ever been caught. The poet speaks of the delight of the astronomer when a new planet swims into his ken. That delight will be no more and no harvest of that deeper sea will be reaped unless we keep our nets overboard for the draught. When we consider the patience of the earlier discoverers in this field it ought to encourage the observers of today to make special systematic observations for particular kinds of objects where, whether the results be positive or negative, they will in any case have value for that ultimate cosmology which the astronomy of the future will produce.

The discovery and observation of asteroids is a highly specialized department of astronomy. With one or two more observatories like that of Wolf at Königstuhl and a closer coöperation among observers, a systematic observation of the opposition point could be kept so far on both sides of the ecliptic, that it ought to be only a matter of a comparatively few years when the problem of what other bodies as bright as the fourteenth magnitude compose our solar system will be a long way toward solution. Among the byproducts of this work will be the discovery of comets, periodic and otherwise, and the possession of a large number of photographic plates which will have great value in other lines of astronomical investigation which the future will demand. Finally if there are any members of this association having a large refractor which they would like to devote to the observation of new asteroids, I would be glad to keep them supplied with material, and they will find the work very easy if they make use of the Wolf-Palisa star charts for their identification.

THE VARIABLE STARS.

FR. ARGELANDER.

Translated from the German by Annie J. Cannon.

Concluded from page 156.

A further proof, and certainly the most irrefutable, of the certainty which one attains by some practice in the estimates, is afforded by the comparison of two series of observations which are made by different observers, in places distant from each other, and often under quite different circumstances, as for instance, mine, obtained at the same time as those of my friend Heis, in Aachen. Since the time when Heis adopted my method of observing, which gives somewhat surer results than that used earlier by him, up to the end of the year 1842, we have 174 observations of δ Cephei and β Lyrae which are so nearly simultaneous that they can be reduced without error, by means of the light curve, to the same moment of time. They show that the sum of the differences between us $= 154.7$, whereby the probable error of a difference $= 0.752$, and, therefore, after dividing by the square root of 2, the probable error of each observer $= 0.531$, nearly the same as that derived from my observations alone. A rather greater, indeed, was given by 57 observations of η Aquilae, namely 1.049; but it is to be noticed that this star was observed by chance very frequently too near to the horizon, also in the case of several observations of Heis, mistakes appear to have occurred; if these are excluded, then we obtain nearly the same error as before.

I am speaking so much at length upon this point because I wish to furnish as undeniable a proof as possible that the observations of variables with naked eye and without photometric instruments, give results which deserve confidence, and which are well adapted for the ascertainment of the peculiarities of these stars. But when we consider that in the case of many of these stars the whole variation, which is sometimes passed through twice in a few days, amounts to hardly 4 grades, and for others does not surpass 8 or 10 grades, so we see that in relation to this small variation, the probable error of any observation is always very important and that only its reduction by means of the multiplication of estimates can lead to a precision, which in some measure comes

near to that attainable in other branches of astronomy. One or two observers are not adequate for this purpose; should the observations be repeated every hour or half hour, they would have no very great precision, for the earlier observations would always influence the later, and no independent, therefore no sure, result would be obtained. Especially are more observers necessary for the variables of short period, so that we may compute their light curve independently for each period, and recognize their irregularities by comparison of the different curves. Could we be aided in this matter by the coöperation of a goodly number of amateurs, we would perhaps in a few years be able to discover laws in these apparent irregularities, and then in a short time accomplish more than in all the 60 years which have passed since their discovery.

Therefore do I lay these hitherto sorely neglected variables most pressingly on the heart of all lovers of the starry heavens. May you become so grateful for the pleasure which has so often rewarded your looking upward, which has constantly been offered you anew, that you will contribute your little mite towards the more exact knowledge of these stars! May you increase your enjoyment by combining the useful and the pleasant, while you perform an important part towards the increase of human knowledge, and help to investigate the eternal laws which announce in endless distance the almighty power and wisdom of the Creator! Let no one, who feels the desire and the strength to reach this goal, be deterred by the words of this paper. The observations may seem long and difficult on paper, but are in execution very simple, and may be so modified by each one's individuality as to become his own, and will become so bound up with his own experiences that, unconsciously as it were, they will soon be as essentials. As elsewhere, so the old saying holds here, "Well begun is half done," and I am thoroughly convinced that whoever carries on these observations for a few weeks, will find so much interest therein that he will never cease. I have one request, which is this, that the observations shall be made known each year. Observations buried in a desk are no observations. Should they be entrusted to me for reduction, or even for publication, I will undertake it with joy and thanks, and will also answer all questions with care and with the greatest pleasure.

It now remains for me only to add short notes on the appearances and peculiarities of each star, so far as they are known at the present time. The brightness of the comparison stars

given here depends upon the differences between the several stars estimated according to my grade intervals. Other observers will use other intervals, according to whether they take the unit greater or smaller. The magnitude will be exactly the same, if brighter and fainter stars are always compared; for convenience of reduction, it is desirable that all observers take the same unit as a foundation, and hence grow accustomed to estimate the grades, so that the mean differences of the comparison stars will give nearly the same results as indicated here.

1) Mira or o Ceti. This star shows, as already mentioned, great differences in its various appearances; according to the observations of Bode, Herschel and Wargentin, it was remarkably bright in the year 1779, brighter than all stars of the second magnitude, and nearly equalled Aldebaran, while at other times it has been seen in greatest light only a little brighter than δ Ceti and fainter than α Piscium, thus between the 4th and 3.4 magnitude. It is generally about as bright as γ Ceti, therefore brighter than the magnitude 3.4. Whether it is completely invisible in its least light, or only needs very powerful telescopes to be seen, is not yet certain. Its mean period appears to be 332.044 days, from which, however, some maxima deviate as much as 40 days; indeed, in the year of its discovery 1596, the maximum occurred according to this period on March 21, while Fabricius observed the star on August 13 as still of the 3rd magnitude. We are not able to derive any tenable conclusion from this, since more exact information concerning that appearance is wanting. In the year 1844, the maximum will occur about May 18, and because of the star's proximity to the Sun, it can not be observed. About the middle of March in the evening hours and in July in the morning hours, one may perhaps be able to perceive it as a star of the 6th magnitude. The course of the light variation can be reckoned with any certainty from only a few of the earlier appearances, for great differences appear, because so many of the observations are on the decreasing side. The length of the visibility with naked eye ranges from 90 to 135 days. It generally increases in a few days from the 6th to 4th magnitude, the increase being noticeably faster than the decrease; in the year 1661, the time of increase was equal to that of decrease, but in 1840, it required 61 days to rise from the first visibility with the naked eye to maximum, while it returned in 50 days again from this to the 6th magnitude. In some ap-

pearances, during the decrease, when the star is of about the magnitude 5.4, there is an apparent inflexion of the light curve, but which is too small, however, to draw any conclusion from it, unless confirmed by numerous observations. The light values of the comparison stars are not precisely enough determined; provisionally, I take 63 Ceti = 0, 75 *C.* = 5, $\nu C.$ = 10, $\lambda C.$ = 14, $\xi' C.$ = 17, $\mu C.$ = 18.5, $\xi'' C.$ = 19.5, $\delta C.$ = 22.0, α Piscium = 26.3, $\gamma C.$ = 27.8, $\alpha C.$ = 34.5, β Aurigae = 40, $\beta C.$ = 41.5, α Arietis = 43.

2) χ Cygni. This star also shows very important irregularities: at maximum it is commonly of the 5th magnitude, somewhat brighter than 17 Cygni, but at times it is of the magnitude 4.5, coming near to η Cygni, while again it appears barely of the 6th magnitude. In minimum, it is invisible. Its mean period is 406.0575 days, with a probable uncertainty of one hour; the deviations from this have a range of about 40 days, and appear to follow a certain regularity, falling on the same side of the mean for several years, during which time they gradually become greater and then again decrease. Such maxima in the deviations appear to have occurred in the years 1725 and 1818, when the star came to its greatest light too late, and in 1758, when it came too early. Now the period is somewhat regular, and the star will be in maximum in 1844 on Aug. 10. The star is visible to the naked eye 2 or 3 months, 4 months longer in a comet seeker, and generally increases somewhat faster than it decreases, the difference being about 10 days. While decreasing, it certainly showed, in the year 1842, and probably also in 1841, an inflexion of the light curve, of which the observations of the year 1843 gave no trace; the earlier appearances are not precisely enough observed to be able to derive any information about this. Most of the comparison stars are to be found on the chart of this region, made by Olbers, and the corresponding catalogue (Zeitschrift für Astronomie Bd. II. p. 198); I place beside the numbers of Olbers the letters used by me, and the other designations. The magnitudes are not very precisely determined; I adopt the following: 28 *O.* = *P.* xix. 300 = *g* . . 4.0; 29 *O.* = *l* . . 6.5; 25 *O.* = *k* . . 7.6; 23 *O.* = *P.* xix. 295 = *c* . . 13.0; 15 *O.* = *e* . . 14.3; 68 Cygni *B.* = *a* . . 14.8; 5 *O.* = 67 Cygni *B* = *f* . . 16.0, 9 Cygni = *b* . . 18.5; 14 *O.* = 17 Cygni = *h* . . 22.6; ϕ Cygni 25.0; η Cygni 30.0; *f* and the brighter stars are visible with the naked eye, *a*, *e* and *c* in an opera glass.

3) 30 Hydrae Hevelii is never visible for a long time on account of its extreme southern declination, and is therefore

only very slightly observed. It appears also not always to reach the same magnitude in maximum but to vary between the magntudes 3.4 and 4.5; in minimum, even in telescopes, to be invisible. Its period derived from the few available observations, is 493.855 days, with a probable uncertainty of 4 hours; the deviations from the period are about 20 days. In 1844, the star will reach its maximum light about Nov. 24, and then can only be seen with difficulty in the morning dawn; first in the year 1846 when it reaches its maximum about April 2, and culminates soon after midnight, we shall be able to thoroughly investigate the course of its light variation, and it is especially desirable that it should then be zealously observed, for now we know almost nothing about it. It is to be compared with the stars b = *P.* xii. 86, a = 348 Hydrae *B.*, which a very sharp eye ought to be able to see, c = 57 Virginis, d = 55 Virginis, ψ and γ Hydrae.

4) Algol or β Persei is one of the most remarkable of the variable stars; it may be asserted with great probability, that its period gradually becomes shorter; a decrease of about three quarters of a second being shown since its recognition as periodical by Goodricke in 1782, which is confirmed by the intervening observations. Could the observations of Montanari and Maraldi be found, even were they ever so rough, the least doubt might be removed as to this decrease. The period is now $2^d\ 20^h\ 48'\ 58''.00$, precise to a fiftieth of a second. The greatest part of the time the star remains in constant light, of a faint 2nd magnitude. When it commences to decrease, it descends in 3 to 4 hours to the 4th magnitude, remains there about a quarter of an hour, and then increases in 3 to 4 hours back again to the 2nd magnitude. In order to determine precisely the time of minimum, one must commence the observations an hour before minimum, when the star is about the 3rd magnitude, and continue an hour after, and during this interval make comparisons, at first every 10 minutes, then every 5 to 6 minutes, with the stars coming each time nearest to the variable in brightness. The adjacent star ρ Persei is well adapted for comparison in minimum, and also α Trianguli, which, however, is somewhat more distant. For comparison during the increase and decrease of light, appropriate stars are γ Andromedae which is 2 grades brighter than Algol in maximum, and then ζ, ϵ, γ, δ Persei and β Trianguli. The star increases rather faster than it decreases; but the manner in which this occurs

is not yet known, and observations every quarter of an hour would give very interesting results, especially if the observation of Arago should be confirmed—that it changes its brightness very rapidly when passing through the 3rd magnitude. In this portion of the light curve, very frequent observations should therefore be secured. For this, only a knowledge of the time intervals is necessary, while in order to determine the epoch of minimum for the purpose of deriving the period, the absolute time, precise to a couple of minutes, must be known. Whether irregularities occur in the light curve, is difficult to determine by isolated observations; still I believe I have noticed them as well in the length of the period, as in the brightness, while the observed time of minimum frequently deviates from the computed more than we should expect considering the precision of the observations, and the star is sometimes fainter and sometimes brighter than ρ; yet ρ itself may possibly be somewhat variable.

5) η Aquilae. The period of this star appears to have undergone changes, but not very important ones; the mean period, probably accurate to a second, is $7^d\ 4^h\ 13'\ 53''$; of this time the star uses only $2^d\ 9^h$ for increase, which is twice as rapid as the decrease. The irregularities in the light curve of different periods, appear to be considerable and if one could depend upon the observations of Pigott and Goodricke, which, however, because of the vagueness of certain phrases used in the comparisons, are not very precise, it would thereby appear that the light curve itself had changed considerably since their time. It would follow from these observations, that the star had formerly increased more rapidly, remained longer in the vicinity of maximum, and then had decreased to minimum in a regular course, while the new observations show two noticeable inflexions in the curve during the decrease. In maximum, it reaches the 3.4th magnitude, at minimum it generally descends to the 5.4th but at times only to the 4.5th. The comparison stars, all in the Eagle, or in Antinous, properly speaking belonging to the Eagle, and their adopted light values are, ν . . — 2.0, μ . . — 1.0, ι . . 3.0, ϵ . . 5.8, β . . 8.0, δ . . 13.0. The following table gives the light curve and shows the brightness every 4 hours in grades and tenths above the zero point assumed as the foundation of the brightness of the stars. The slight differences between this and the one given in *Astr. Nachr.* No. 455, originate from a new reduction, depending on more observations. The first minimum of the year 1844 occurs

on January 7, $1^h\ 35'\ 0''$; I do not give the times of other minima nor of maxima, for they can easily be computed by means of the period and light table, and the observations in all phases are equally important.

LIGHT TABLE.

d	h	d	h	d	h	d	h	d	h	d	h	d	h	d	h
0	0	1.9	1	0	5.1	2	0	10.3	3	0	9.9	4	0	7.7	5	0	6.1	6	0	4.2	7	0	2.1
	4	2.0		4	5.9		4	10.8		4	9.5		4	7.5		4	5.7		4	4.0		4	1.9
	8	2.4		8	6.8		8	11.0		8	9.1		8	7.4		8	5.3		8	3.7			
	12	2.9		12	7.7		12	10.9		12	8.6		12	7.2		12	5.0		12	3.3			
	16	3.6		16	8.6		16	10 6		16	8.2		16	7.0		16	4.7		16	2.9			
	20	4.3		20	9.5		20	10.3		20	7.9		20	6.5		20	4.4		20	2.5			

6) β Lyrae has an extremely remarkable light variation, since two maxima and two minima occur during each period. In the first minimum, it decreases to the 4.5th magnitude, in the second to the 4.3; in both maxima, it reaches very nearly the same, the 3.4th magnitude, since in the second it is only one half grade fainter than in the first, but it remains considerably longer therein. Both of the increases of light and the second decrease towards the primary minimum, take place very rapidly. The first light decrease takes place somewhat slower, as may be seen from the following Light Table, which is arranged like that of η Aquilae. It shows moreover, that both minima, as well as the two maxima, are separated from each other by very nearly half the length of the period. The period is now $12^d\ 21^h\ 53'\ 10''$, but as it is derived from the observations of Heis and mine alone, it is about 2 minutes uncertain. In all

LIGHT TABLE.

d	h		d	h		d	h		d	h		d	h	
0	0	2.9	3	0	12.5	6	0	8.5	9	0	11.9	12	0	6.1
	4	3.0		4	12.4		4	8.5		4	11.9		4	5.0
	8	3.3		8	12.2		8	8.4		8	11.9		8	4.1
	12	4.0		12	12 0		12	8.4		12	11.9		12	3.5
	16	5.6		16	11.7		16	8.5		16	11.8		16	3.1
	20	7.2		20	11.4		20	8.6		20	11.7		20	2.9
1	0	8.5	4	0	11.0	7	0	8.9	10	0	11.6	13	0	2.9
	4	9.3		4	10.6		4	9.3		4	11.5			
	8	10.0		8	10.3		8	9.9		8	11.3			
	12	10.6		12	10.0		12	10.5		12	11.2			
	16	11.0		16	9.8		16	10.9		16	11.0			
	20	11.4		20	9.6		20	11.2		20	10.8			
2	0	11.6	5	0	9.3	8	0	11.4	11	0	10.6			
	4	11.9		4	9.1		4	11.5		4	10.3			
	8	12.1		8	9.0		8	11.7		8	9.9			
	12	12.2		12	8.8		12	11.8		12	9.4			
	16	12.4		16	8.7		16	11.9		16	8.5			
	20	12.5		20	8·6		20	11.9		20	7.4			

probability, it was formerly shorter and it appears as if each following one is about 4 seconds longer than that immediately preceding. And besides this gradual lengthening, other irregu-

larities appear, at least in the brightness. The comparison stars, with the exception of o, which is o Herculis, are all in Lyra, and their brightness δ . . 2.0; ζ . . 3.2; ε . . 4.8; ο . . 7.6; γ . . 12.7. Whoever sees ε Lyrae double, can not use it as a comparison star. The first primary minimum of the year 1844 occurs on Jan. 10, 23^h 1′ 0″.

7) In the Lion, No. 420 Mayer, is so seldom and incompletely observed that there is nothing further to say, than has already been said in the Table.

8) δ Cephei. It has already been stated of this star that it has the most regular light change of all the variables. The period which is constant, within the errors of observation, and precise to one half a second, $= 5^d\ 8^h\ 47'\ 39''.5$, and all the old and new observations accord with the same light curve for which the Light Table is given below. According to this, the star rises from the 4.5th to the 4.3rd magnitude in $1^d\ 14^h.5$ and from that time increases, at first more rapidly, then during about 12 hours quite unnoticeably, later again somewhat rapidly but always very gradually. The comparison stars, with the exception of a, which is 7 Lacertae, are in Cepheus, and their light values are ε .. 2.0; a .. 7.1; ι .. 10.6; ζ .. 11.4. The first minimum of the year 1844 occurs on Jan. $4^h.13^h$ 38′ 14″.

LIGHT TABLE.

d	h		d	h		d	h		d	h	
0	0	2.8	1	8	9.9	2	16	8.3	4	0	4.8
	4	2.9		12	10.5		20	8.0		4	4.5
	8	3.2		16	10.6	3	0	7.6		8	4.1
	12	3.8		20	9.8		4	6.9		12	3.8
	16	4.7	2	0	9.0		8	6.3		16	3.5
	20	6.0		4	8.6		12	5.8		20	3.3
1	0	7.4		8	8.4		16	5.4	5	0	3.1
	4	8.8		12	8.4		20	5.1		4	2.9

9) α Herculis. If Herschel's observations are not very carelessly made, and this can scarcely be believed, then the period of this star has changed since his day, from about 60^d to $94^d\ 21^h$; for only with this will my observations accord; those of Heis indicate a somewhat longer period. The star is difficult to observe precisely, for its whole change amounts to only about 4 grades, and deviations from the mean which appear in the length of the period and in the brightness, are greater than could be ascribed to errors of observation alone, and the star must therefore be observed so much more carefully and continuously. It requires about 52 days for increase, and only 43 for decrease, yet these figures are very uncertain; nothing

further concerning the course of the light curve can be said. The first minimum of the year 1844 will occur Jan 31. For comparison I use both the stars κ and β Ophiuchi, which I call *a* and *c*; I take their brightness as *a* .. 2.0, *c* .. 5.8.

10) In the Northern Crown. P. XV. 185. This star has the peculiarity that it is only variable at certain times, then again for many years it remains unchanged at the 6th magnitude. Since the latter is now the case, I can say nothing further, than was inserted in the Table according to Westphal.

11) In Sobieschi's Shield, 59 according to Bode. This star has a mean period of $60^d\ 9^h\ 29'$, which is determined with some certainty, and of this it requires 34 days and 9 hours for increase and only 26 days for decrease; since the difference of these figures is only subject to a probable uncertainty of a little over 2 days; therefore the star appears truly to decrease faster than to increase. Very important irregularities are found in the light changes; in the length of the period they extend to 20 days or more and still more significant are those in the brightness, since the star sometimes reaches the 5th, but often only the 6th magnitude, and in minimum sometimes the 6th or, more exactly the 6.7th magnitude, while at other times to the 7.8th, and again decreases even as far as the 9th magnitude. Pigott worked industriously with this star, and his collected results are quite interesting, although it is greatly to be desired that he had given his observations in the original. The comparison stars and their light values are: *c* .. 10.0; *g* .. 12.9; *h* .. 14.0; *k* .. 16.4; *g* and *h* are the stars in the Eagle designated by the same letters, *k* is 7 Scuti Hev. = 9 Aquilae, *c* = 61 Scuti B. The first minimum of the year 1844 will occur on Feb. 22, the first visible maximum on March 27.5.

12) In the Virgin. According to Wurm, who is responsible for the figures in the Table, this star also shows important irregularities in its period, less in its brightness. It is invisible about 45 days, or much fainter than the 11th magnitude, then in 44 days, apparently at first more rapidly, then gradually, increases to maximum, and decreases in 52 days, at first gradually, then more rapidly, to invisibility. I have not yet observed it and can therefore give no comparison stars. The first maximum of 1844 will occur on Jan. 4.

13) In the Water Carrier. This star follows, and is somewhat north of 368 Aquarii B., which is given in my Uranometry about one degree south of ω^2 Aquarii and of the 6th magnitude. This star, the variable and the three comparison stars

c, b, a, are arranged roughly in a half circle around ω^2; I take the light values as $c = 5$, $a = 6$, $b = 8$. The period is yet very uncertain, and nothing more precise is known concerning the light change. The maximum of the year 1844 will occur about Oct. 21.

14) In the Serpent. The period is still very uncertain, the comparison stars stand in a line with the variable, b preceding, a following; I assume for their light values, a .. 4, b .. 7. Nothing further can be said about the nature of the light change. The maximum of the year 1844 will occur about June 3.

15) In the Serpent. Also of this star there is nothing more to be said, but that its period may still be uncertain a whole day, and its maximum in the year 1844 will occur about Feb. 4. The star is easy to find, since it stands in a square made by the stars β, γ, υ, ϕ Serpentis, somewhat north of and following the line $\beta\ \phi$, and likewise north of but preceding the line $\gamma\ \upsilon$. For comparison I use the star f, which stands between the variable and β; a, the middle of the three near ϕ; b, which stands on the line $\gamma\ \upsilon$, nearer to υ; c and d, the two brighter, 90 and 91 Serpentis B., which are north of the same line and nearer to γ, and $e = 96$ Serpentis B.

16) α Cassiopeiae on account of its brightness, is one of the stars most difficult to observe; and since the whole variation is only about 4 grades it is very difficult to decide whether the irregularities which appear in the light changes are real or only due to errors of observation. No light curve has been established, nor is it even certain whether the increase is truly, as it appears, 2 days more rapid, than the decrease. The period of $79^d\ 0^h\ 43'$ already given is probably too short. My last observation of maximum and two very old ones, derived from observations made by Goodricke for other purposes, make it over an hour greater, and reduce the probable error in the determination, which is now nearly 2 hours, to one half hour. The first maximum of 1844 will occur an Jan. 10, the first minimum, February 20. The light values of the comparison stars, all in Cassiopeiae, are δ .. 0; β .. 4.3; γ .. 7.0.

17) α Orionis is also yet very little known; its brightness changes about 5 grades, it decreases and increases in nearly equal time, and appears while decreasing to have a still stand lasting about one month, from the 35th to the 65th day after maximum. Its period of 199 days 4 hours is about one whole day uncertain. In the year 1844, it reaches its first maximum on April 5, it first minimum on July 15. The com-

parison stars and their light values are β Geminorum 0; α Tauri 2.0; Procyon 5.1; Rigel 6.3; Capella 9.5; they are not yet very accurately determined; also Rigel and Procyon appear at times to change their relative brightness.

18) α Hydrae. I have only very slightly observed, the observations of others are not known to me, and I can therefore only express the suspicion that its period is perhaps 55 days; it may however be entirely different. The star is moreover, on account of the lack of adjacent comparison stars, very difficult to observe; I have compared it with β and δ Leonis, γ and ϵ Virginis, β Canis majoris, and α Coronae.

RECENT RESEARCHES AS TO THE SYSTEMATIC MOTIONS OF THE STARS.*

LEWIS BOSS.

The proper motions of stars are so small, and are so difficult to measure with proportionate accuracy that the successful determination of systematic peculiarities in the arrangements of the motions themselves must depend upon great systematic accuracy in the measurements of those motions. Therefore, when the department of meridian astrometry was established at the Dudley Observatory about six years ago with the support of the Carnegie Institution of Washington, its first work of investigation was to continue to completion the work it had begun with the object of ascertaining the proper motions of the brighter stars which had been most observed with precision in the past, with all practicable completeness and accuracy, both in the casual and systematic sense, with the ultimate purpose of making this work the basis of studying the systematic peculiarities of these motions in order to throw further light on the mechanism of the visible universe.

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* Reprinted from *Science*, Feb. 9, 1912. An abstract from a paper presented by Professor Lewis Boss, Director of Dudley Observatory, to the joint meeting of the Astronomical and Astrophysical Society of America and Section A of the American Association for the Advancement of Science, Dec. 29, 1911.

About two years ago the Carnegie Institution of Washington published the result of this research in a volume entitled "Preliminary Catalogue of 6,188 Stars." For each star the position was given for 1900 together with the proper motion, etc., necessary for reducing those positions to any other epoch. This material was first employed for deriving new values of the precession as well as the direction of solar motion. The latter was found to be, for 1875: R. A. 270°.7, Decl. +34°.3 (A.J.614). The stars employed in this discussion cover the entire sky from the north to the south pole; so that the direction of the solar motion came out with very great weight and at the same time independently of the precession.

Next were deduced the facts in regard to an interesting moving cluster of stars in the constellation *Taurus*. Each of the 41 stars appears to be moving toward a point in the sky in R. A. $6^h\ 7^m$, Decl. + 7°. The velocities of motion of the several stars are approximately the same. Very recently Mr. Benjamin Boss, of the department of meridian astrometry, identified a group of eleven or twelve large proper motions scattered widely over the sky between declinations +42° and −81°, which converge nearly in a point at R. A $6^h\ 37^m$, Decl. + 0°.5. The velocities of these stars toward the point cited seem to be uniformly about 95 kilometers per second. 61 Cygni appears to be a member of this group (A. J. 629).

Before seeking a systematic representation in direction and amount of the star motions generally, the speaker had wished first to follow up the indications which had already appeared to the effect that the stars of differing spectral types are moving with differing mean velocities. Frost, eight years ago, had offered the earliest evidence that the Helium, or *Orion*, stars are moving slowly in comparison with those of older types. Quite recently he and Kapteyn and also Campbell added some preliminary evidence to the discussion of this question. In the winter of 1910-11 the department determined to take up this subject comprehensively by employing the cross-motion element of the proper motions. The results of this research on acceleration of stellar motion were published in the *Astronomical Journal*, Nos. 623 and 624. These results are given in the following table under the column designated "mean cross motions." For comparison, Campbell's results from mean radial motions are given in the next column. They were obtained from entirely different sources, independently and almost simultaneonsly. The letters in the first column, in which *B* is supposed to stand

for the youngest spectral type (Helium), and *M* for the oldest considered in this investigation, are designations adopted from the Harvard classification (H. C. O., Vol. L.)

Type	Mean Cross Motions	Mean Radial Motions
B	6.3	6.2
A	10.2	10.5
F	16.2	14.4
G	18.6	15.9
K	15.1	16.8
M	17.1	17.1

The cross motions were originally expressed as a fractional part of the centennial motion of the sun. Both series, in good agreement, express the fact that the motion of a star accelerates up to about the time the spectrum develops into type *F* or *G*, after which it seems to gain no increase of velocity.

Seven years ago Professor Kapteyn, at the Scientific Congress of the St. Louis Exposition, introduced his now well-known hypothesis that the visible universe consists of two great intermingling streams moving in opposite directions. The direction of one he called the "vertex," which he fixed at R. A. $6^h\ 4^m$, Decl. + 13°. Quite recently Eddington of the Greenwich Observatory, with the same hypothesis, and using the proper motions of the "Preliminary General Catalogue," found for this vertex: R. A. $6^h\ 16^m$, Decl. + 12°.

In 1907 Schwarzschild advanced the hypothesis that a systematic arrangement of the proper motions leads to an ellipsoidal arrangement of distribution and he endeavored to show that the proper motions of Groombridge's Catalogue are as well represented as they are by the hypothesis of two streams.

By a method entirely different from that employed by either of the two investigators, the department found nearly a year ago that when its proper motions were compared in a manner to bring out this systematic arrangement, it was seen that if all the actual motions of the stars in any considerable area of sky were brought to a common origin (freed from their solar parallactic motions) the figures so constructed would have an elliptic outline, which turned out to be different presentations of an ellipsoidal figure of which, if the major axis be taken as 7, the two minor axes would be 4. The major axes of all the figures points very nearly towards the vertex of Capteyn; this point was found to be in R. A. $6^h\ 15^m$ and Decl. + 7°. Moreover, these ellipsoids have well-marked nuclei composed chiefly of stars of types *B* and *A*. This fact would require a third stream to complete the "two stream" hypothesis, as some of the supporters of the latter have already perceived.

The speaker presented considerations in support of his belief that this ellipsoidal arrangement of the star-motions in space would be reduced to a simple and natural explanation, if we suppose that the stars had been originally formed in nebulas and repelled from the regions of their formation with a tendency to be impelled by some kind of polarity 50 to 75 per cent. faster in the direction of the major axis of the ellipsoid than in the direction at right angles to that. This hypothesis also fits in well with the undoubted phenomenon of acceleration of a star's motion with age.

SENSE PERCEPTION OF STAR DISTANCE.

FREDERIC CAMPBELL.

Doubtless the ancients had an idea of a difference of distance among the stars, but it must often have been greatly mistaken. In general, the brightest stars seemed nearest and the faintest farthest. But this principle is often found false. Among the sixteen nearest stars which the Astronomer Royal of England enumerates as the only ones within a distance of about 95 trillion miles from our sun, there are not only the first magnitude stars Sirius, Alpha Centauri, Procyon and Altair, all of which might be suspected of nearness by reason of their brightness, but also several stars of the eighth and ninth magnitudes, too faint to be seen with the naked eye, and hence seemingly very remote.

We should be quite in the dark touching the comparative distances of the stars, were we not able to secure a parallax by reason of the earth's semi-annual shift of position from one side to the other of its orbit. By this aid we have ascertained, with a large degree of accuracy, the distances of some 300 stars, and some approximation to the distances of others is obtained otherwise.

As the eye fails to detect the differences in star distances in the sky, so it is impossible to represent them on the printed page, whether by photography or the printing press, in such a way that the eye will do any better.

The device of the stereoscope may be employed, however, to enable the mind to get a sense-perception otherwise denied. We know that the stereoscopic picture possesses "depth," solid-

PLATE V.

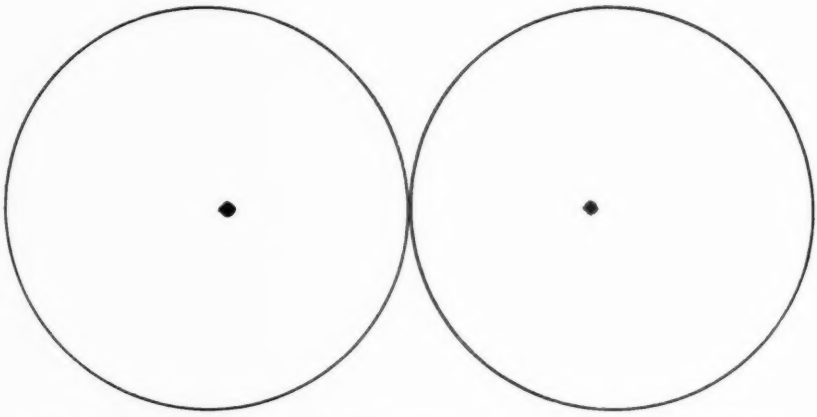


FIG. 1—Illustrating Stereoscopic or Binocular Vision; Opposite Displacement of a Nearer Object.

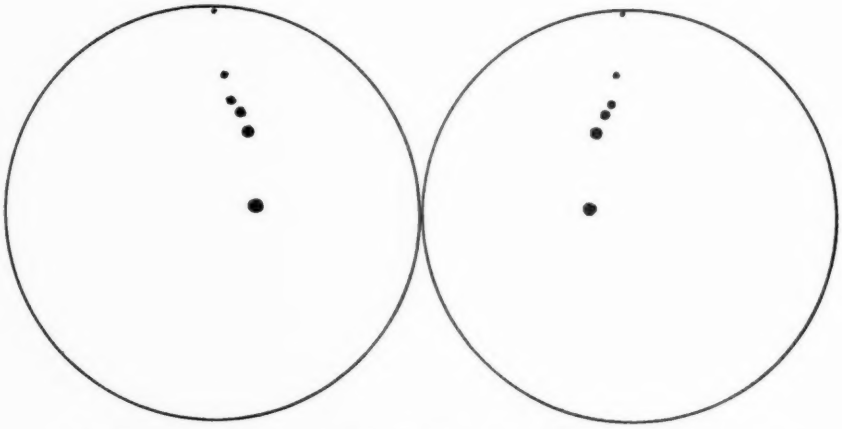


FIG. 2—Stereoscopic View of Six Nearer Stars, giving a Sense-perception of Their Relative Distances.—Designed and Drawn by the Author.

SENSE PERCEPTION OF STAR DISTANCE.

ity, perspective, distance, as an ordinary picture does not. Seeing with two eyes,—binocular vision,—is what accounts for this. Each eye sees from a slightly different position from that of its mate; and the two pictures seen are slightly different from one another, having been taken from different points of view. If they be exactly alike there is no special sense of depth or distance. But if nearer objects are displaced toward each other, and this displacement be less and less as objects are more and more remote, we get the idea of distance.

Some can command the stereoscopic vision without the actual use of the stereoscope. With the double stereoscopic picture before one, let each eye look straight ahead, the right eye at the right circle, and the left eye at the left circle, till the two blend into one. This is very difficult at first, but the writer has found that it can become very easy by practice. It is nothing more nor less than the distant look, the fixing of the eyes so that their lines of sight are almost parallel with each other. This is always easy when we gaze at a distant object. Let one strongly imagine himself to be so gazing when he places the stereoscopic picture before him, and suddenly he will find that he has succeeded; and the moment he succeeds, it matters little what the subject of the picture may be, the sense,—not the idea, but the sense,—of distance, depth, perspective, takes such possession of him, that he involuntary exclaims, "How beautiful!"

Figure 1, accompanying this article, will enable one to practice. The paper should be held smooth, parallel to the line of the two eyes and should be evenly lighted. One should select a point midway between the two circles, or where they touch each other, and, with severe effort, strive as if to see a very distant imaginary object *through* that as an opening. If necessary, make the opening with a pin point, thus aiding the imagination. This straightens the vision in such a way that suddenly each eye picks up its own circle, the two blend, and the displaced spots merge into one which hangs suspended in the intervening air.

Figure 2 endeavors to apply this principle to five familiar stars of the nearest sixteen already mentioned, namely, the four named above, and 61 Cygni, and adds one of four that happen to be equally at the extreme distance of the arbitrary 95 trillion miles. This figure is to be employed in the same way. By reason of the smaller parallax of the more distant stars, the displacement is less, in a definite ratio. Hence, when one obtains the stereoscopic vision of this drawing, he distinctly sees

these six stars, not standing in a vertical line, above and below each other, but in a horizontal line, leading from himself to the paper, hanging in empty space at distances varying according to the parallax and displacement shown.

In this way one may wondrously obtain the same sense perception of varying star distances, as he would if his eyes were separated by millions of miles instead of 2½ inches: or as he would if he possessed a stereo-binocular, whose object-glasses were as far separated as the positions of the earth at the two extremes of its orbit, 186,000,000 miles. If one's efforts to secure the stereoscopic vision of these drawings be unsuccessful, he has only to cut them from paper and place them evenly and smoothly in a hand stereoscope, to get the same result, and perhaps even better.

If now charts of the heavens might be prepared, displaying stereoscopically the displacements of the three hundred measured stars in proper ratio, and all on the general background of the sky, then by the use of the stereoscope, or even of stereoscopic vision, we should at once obtain a sense perception of difference in star distance.

VISUAL OBSERVATIONS OF RED VARIABLE STARS.

J. A. PARKHURST.

Inquiries from several members of the Variable Star Section lead me to mention again some points in regard to the observations of these troublesome stars. These points have appeared before in POPULAR ASTRONOMY, but they will bear repeating.

(1) *Punch's* famous advice to those about to marry—"Don't", will apply very well to observers of very red stars, until they have accumulated a considerable experience with the easier, less highly colored stars. But, assuming that difficulties will not deter the industrious and courageous members of the section, the following suggestions are offered.

(2) If a white and a red star appear equally bright in a certain field, they will change their relative brightness with change of conditions as regards (a) aperture used, (b) altitude, (c) haze or moonlight, (d) personality of observer, (e) duration

of steady gaze, (f) angle between the line joining the stars and that joining the eyes (this last change will be apt to affect stars of any color). Taking the points in order—

(a) An increase in aperture, giving more light, will make the red stars appear relatively brighter. A decrease will have the contrary effect.

(b) Change in altitude will have a complicated effect. For example, a decrease in altitude would make the red star lose in brightness on account of greater general absorption, but this might be more than balanced by the less amount of selective absorption for the red rays.

(c) It is hard to predict the direction of the effect of haze and moonlight, but they should be avoided.

(d) Eyes vary greatly in their sensibility to red rays, differences exceeding half a magnitude being not uncommon.

(e) Gazing steadily at a red star, it will usually appear to increase in brightness for some seconds. A good rule would be to gaze steadily till this increase ceases before making the estimate.

(f) The line joining the stars to be compared should be parallel to the line of the eyes. If two stars appear equal in this position, then if the head be rotated 90° the lower star will appear to most eyes about half a magnitude brighter, though to some observers there is little or no change.

If the precautions under a, b, c, e, and f, are followed, some experience will enable the observer to get a consistent curve for his own eye; but, on account of (d), his curve will not necessarily bear any definite relation to that found by another observer. Therefore it is not advisable to form a composite curve from the work of different observers, until the relation between their personalities has been determined. These considerations have led the writer to prefer photographic methods, since a proper choice of plates and color-filters will give both photographic and "visual" magnitudes free from the above difficulties except (b.) A statement of the magnitude of a red star as observed with the eye, is not complete unless the conditions mentioned under a, b, c, d, and e are specified; and no longer holds if any one of the conditions is changed.

Yerkes Observatory, March 1912.

A MODERN LOOK AT THE UNIVERSE.

HENRY OLERICH.

Concluded from page 168.

Thus the cycles of changes and developments continue even in the sociological and psychological phases the same as in the physical, and as a whole, the transitional stages are so slight and imperceptible that no one can point out the exact link in the long chain of development where the inorganic ends and the organic begins; where the vegetable ends and the animal begins; where the "animal" ends and the "human" begins; where the physical ends and the psychical begins; where the solitary ends and the social begins; where life ends and death begins. All this seems to confirm the eternal unity, continuity, and ceaseless activity of nature, and so far as science is aware without the slightest loss or gain in the total quantity of matter, energy, and motion; so that nowhere does science know of a creation or an annihilation of ultimate particles, but only of transmutation.

Let me say here that we know that the evolutionary law of the survival of the fittest has, as a whole, been improving every succeeding generation and species. May then not the same law of progress also operate in the succession of worlds and of solar systems, by the process of successive cycles of integration and disintegration of matter, energy and motion? May not our next solar system evolved by the next cosmological cycle be more nearly complete and even more beautiful than is the present one; have more useful metals and a richer soil; evolve better adapted vegetable and animal kingdoms, and a still nobler and more intelligent human family? Successive worlds and solar systems in which there will be an increasing preponderance of good over evil, of science over superstition, of health over disease, of friendship over enmity, of justice over corruption, of leisure over toil, of independence over dependence, and of pleasure over pain.

Could any other cosmological concept be grander and more inspiring to intelligent, progressive minds? For as we have seen, is it not as natural and inevitable to be old as it is to be young; to die as it is to be born; to decompose as it is to grow? Why then should we particularly mourn the demise

that opens up the way for a progressive birth—a better individual, a better species, a better world, a better solar system, a better universe?

STRONG FACTS IN SUPPORT OF THE NEBULAR HYPOTHESIS.

As we have seen, there are many facts that seem to indicate beyond all reasonable doubt that all the conspicuous members of our solar system—sun, planets, moons, etc.,—had a common cosmological origin, and that the sun is the parent of them all. Among the numerous important facts that strongly indicate a unitary mechanical origin may be mentioned the following:—

1. So far as spectroscopic analysis and other scientific researches reveal, the members of our solar system all seem to be composed of substantially the same chemical elements as the sun is.

2. According to the contraction theory of the sun's heat, this body was once vastly larger than at present.

3. All the conspicuous members revolve "around" the sun in substantially the same plane, which approximately coincides with the plane of the sun's equator.

4. All the planets and, with perhaps one or two minor exceptions, all the known satellites also revolve around their primaries in the same direction as the sun rotates on his axis—that is, opposite to the hands of the clock.

5. So far as definitely known, they all rotate on their axes opposite to the hands of the clock, or in the direction of their revolution.

6. Other things equal, the orbital velocity depends on the nearness of the primaries from which they are supposed to have been shed.

7. There is also an almost uniform increase in the density of the primary planets from the remotest to the nearest to the sun. The density of Neptune is about one fifth that of the earth, while that of Mercury is nearly two and a fourth times that of the earth.

8. In general the faster the rotation and the lower the density, the greater the number of satellites.

9. The unbroken ring of Saturn seems to be a strong confirmation of the ring theory and in support of the nebular hypothesis.

10. They all seem to have an igneous origin. For example, the large planets, such as, Jupiter and Saturn seem to be still in a molten state, while the smaller members that have already cooled down, such as our moon and perhaps Mars, show conspicuous remains of former igneous activity.

11. The orbits of the planets and satellites are all nearly circular.

12. Astronomers have so far located more than 10,000 nebulae, many of them apparently very similar to the one we have assumed from which our solar system has slowly evolved to its present form and function. Only a few of the brightest are visible to the naked eye, the remainder are telescopic.

There are many other facts and principles which we can not elucidate here that strongly indicate a common mechanical origin, not only of all the members of our solar system, but also on an infinitely larger scale does it seem to apply also to the universe at large. Our solar system may not exhibit intelligent design; but all the members do certainly exhibit a strong mechanical dependence on one another.

It, therefore, seems highly improbable that all this mechanical harmony and unitary form and motion, which we have briefly pointed out, are mere coincidences of a solar system thrown together at random from flying meteors and other sporadic accretions. Would not such a hap-hazard solar system built on such an accidental plan likely have some planets and satellites revolve and rotate in on direction, and others in different directions; some in one plane, others in other planes, and so with all other forms and functions? We would then have to expect discord rather than the abundant harmony and unity indicated by the nebular hypothesis.

SOME APPARENT DISCREPANCIES OF THE NEBULAR HYPOTHESIS.

As we have seen in the foregoing topics, the nebular hypothesis already accounts for a vast array of important astronomical and cosmological phenomena; but there seem to be, however, still a few apparent discrepancies of details, which in the light of our present knowledge, can not yet be fully accounted for on the theory of the nebular hypothesis. Among these apparent discrepancies may be mentioned the following:

1. The slight inclination of the plane of the sun's equator to the general plane of the system is still unaccounted for.

2. The eccentricities of the planetary orbits are not yet fully understood on the basis of the ring theory.

3. The minor planets and their irregular orbits are not yet satisfactorily explained.

4. The rapid revolution of Phobos, one of Mars' little moons, and the ring of Saturn are still unaccounted for on the basis of the nebular hypothesis.

5. It is claimed by some modern astronomers that the presence of light elements in the earth is not to be expected.

6. A few modern astronomers contend that a series of rings could not have been left off.

7. That a ring could not have condensed into a planet or satellite.

8. The moment of momentum of the present system is claimed to be much less than that of the supposed initial nebula was.

9. The unequal size of the planets is still on open question.

10. The retrograde revolution of Phoebe, the ninth satellite of Saturn is still unaccounted for on the theory of the nebular hypothesis.

Such are the principal apparent discrepancies still more or less unaccounted for on the basis of the nebular hypothesis. It may, however, be said without fear of successful refutation that the important general facts in support of the nebular hypothesis immensely outweigh the few comparatively unimportant details that still await further explanation; but not one of which seems to be necessarily fatal to the general theory of the nebular hypothesis. They can be fatal or serious only on the unwarranted assumption that we are now familiar with the whole net work of forces that ever acted to help produce the still unexplained phenomena; that all the investigations, observations, and computations that have brought to view these yet unexplained phenomena are absolutely correct, and that the conclusions deduced therefrom are incontestably true. But does the history of the past warrant such a claim?

It does not, therefore, necessarily follow that the most commendable theory or hypothesis must at once account for all perceptible phenomena. A glance of the past shows that man does not discover all nature's laws in a "bunch," but one by one. Our knowledge concerning the universe is, therefore, progressive, but not yet coextensive with any system of cosmogony, and so far as we have reason to believe, it never can become completely absolute with an infinite universe, so that there will always have to remain undiscovered realms. Hence, that theory, hypothesis, or system, which accounts for most, but not necessarily for all perceptible phenomena is the best hypothesis, and other things equal, that should be provisionally accepted by everybody that is earnestly searching for the highest truths.

In support of the views here given, I might quote the following from the new Encyclopedia Brittanica just from the press:

"After the omission of all cometary objects, we can still count in the solar system upward of five hundred bodies, almost every one of which pronounces distinctly, though with varying emphasis, in favor of the nebular hypothesis."

This extensive harmony is, no doubt, the reason why the general acceptance of this natural, beautiful, and we believe truthful form and function of the universe has been so rapid during the last half century that it now forms the scientific cosmological basis of perhaps more than nine-tenths of all modern text-books used in the public schools, libraries, and universities of the world.

The introduction and rapid development of the nebular hypothesis forms such a supremely important epoch in the progress of human thought and welfare, because it is the first cosmological theory founded on the natural facts and real causes of the universe, while all former cosmogonies rested primarily on ancient mysticism. Hence, it seems to me that for preponderance of truth, delicate regularity, beauty of thought and mechanical simplicity, the nebular hypothesis as now advocated or modified to harmonize with future discoveries, stands today as the crowning triumph of man's intellectuality; that it is the grandest and most sublime theme ever contemplated by the human mind, binding together by an indissoluble bond, the physical, geological, biological, sociological and psychological phases of the known universe. The writer shares the belief of the late Professor S. Newcomb, before quoted, as well as a host of other brilliant investigators, that the nebular hypothesis explains an immense array of facts, and has never yet been conclusively proved inconsistent with any fact.

A QUESTION ON THE CAPTURE THEORY.

N. W. MUMFORD.

Below may be found a very brief summary of Professor See's monumental quarto volume on Cosmogony, concluding with an apparent exception to his theory.

The matters of greatest interest brought forward in the volume are: the theory of a general prevalence of a resisting

medium in space, the assumption of the existence of such a medium in the typical or spiral nebulae, and the tracing of the evolution of the solar system from a nebula of that class.

The author undertakes to show how the innumerable points of condensation in the vast nebular coils must revolve about the central nucleus, gradually uniting with each other under the force of gravity, and producing comparatively small globes or planets, whose orbits are reduced in size and rounded under the secular effects of the resisting nebulous medium. In the solar system this process is said to have practically cleared the interplanetary spaces of nebulous matter, and to have evolved a highly stable cosmical figure, but doubtless one very far from unique among the millions of single suns. Among the smaller masses in the original nebula, a certain proportion would be captured by the bodies of planetary size and permanently held, owing to the force and the effects of the resisting medium. All moons captured in this way would not necessarily revolve about their primaries in the same direction. The prevailing rain of meteorites and cosmic dust during the clearing up process would produce planetary rotation in one direction. Other so-called moons, not captured by the planets, take up regular planetary orbits, becoming asteroids, and still other bodies, visitors from the region of the outer shell of the original nebula describe nearly parabolic orbits, (except when such orbits are transformed by the action of large planets) approaching the central luminary at long intervals, and appearing as comets.

The stars themselves would appear to be condensations of nebulosity, adding to their own bulk by accretions of enormous amounts of waste matter attending them, and often appearing as double, triple and multiple suns, when two or more dominating centers of condensation sweep up the nebular strays and settle into orbits about their common center of gravity. The variable stars would seem to be those pairs whose plane of revolution lies in line with our sun, and whose orbital movements, when the plane is thus situated, would produce eclipses; or else pairs revolving in long ellipses, about a common center, that appear to encounter considerable resisting medium on close approach, causing them to flare up or fluctuate in brightness. New or temporary stars would seem to be those produced by collision between a planet, a satellite or large comet, and its central sun, causing a sudden conflagration; or one of the dark bodies of planetary size wandering in space, might

enter a small nebula, the result being the blazing forth of a new star. The author regards the collision between sun and sun as a possibility so excessively remote that by the law of chances it practically never occurs.

The clusters of stars would appear to be the result of many condensations in nebulae of extraordinary extent, whose combined power of gravitation may attract neighboring suns into the mass; and the more diffuse star clouds seem to be gathered in somewhat the same way, but without regularity of form or condensation toward a common center. The galaxy would appear to be the grand aggregate of nearly all the star clouds and clusters, spanning the heavens as an arch or girdle that embraces the visible universe. This stratum of stars is supposed to extend outward in its own plane indefinitely. The existence of the coal sacks receives no satisfactory explanation.

The maintenance of the balance in the making and unmaking of the suns is thus described: "on the one hand, nebulosity in the finest known state is expelled from the stars and drifts hither and thither through the universe, till it collects into cosmical clouds or nebulae; on the other hand, these nebulae in turn condense and form fixed stars surrounded by cosmical systems. This is the inevitable outcome of the condensation of the cosmical dust expelled from the stars; while the dust collecting into nebulae is originally dispersed by the intensity of repulsive forces which may be traced to the high temperature and intensity of the light and electric forces operating in the stars. When the nebulæ condense into stars, it is probable that by an unknown circulatory process they again drift back towards the medial plane of the galaxy. Thus there is an expulsion of dust from the starry stratum, and a subsequent recovery of this matter in the form of mature stars.....We may regard this cyclic process as perhaps the greatest of all the laws of nature." Attention is called to the recognized affinity of the majority of the nebulae to the poles of the galaxy.

In this briefest possible summary, the steps cannot be traced showing how the author arrives at his various conclusions. Each detail of the structure of the heavens is analyzed—with one important exception, the dark stars. Casual mention is made of "dark bodies of planetary size wandering in space," but the opaque non-luminous bodies comparable to the sun in mass are not considered.

We have every reason to believe that the dark stars are exceedingly numerous. Hitherto the study of stellar evolution

has concerned itself very largely with the rise, culmination, wane and extinction of the suns. The new astronomy was lately born and has made a vigorous growth under spectroscopic analysis. In at least sixty cases dark stars may be all but observed telescopically, by their passage over the face of luminous suns, producing variables of the Algol class. Naturally different degrees of darkness, down to the absolute, prevail among such stars. There is scarcely an observer of the heavens who has not committed himself to the prevalence of numerous dark bodies, in all regions of the sky, and to the proposition that such bodies were once self-luminous. It has been stated, by Professor Stoney for example, that the dark bodies far exceed in number the visible stars. Who is bold enough to assert that the light of each sun is from everlasting onward to infinity? It is as safe to say that each star runs its course to darkness, as it is to trace the rise of each from a nebulous cloud; and the latter proposition Professor See takes pains to demonstrate. But the revivifying of dead suns through collisions he denies, nor is any discussion offered on the existence of such bodies.

A little consideration of the facts forces the alternative, either that the dark stars have some means of rejuvenation untouched upon by Professor See, or else that the cycle pointed out, from star to nebula and from nebula back to star is inadequate for the maintenance of the visible universe.

The dark stars form a considerable class. Their ranks are recruited by the waning and extinction of light giving bodies. They must steadily increase in numbers, if, with the author, the absence of means of rejuvenation is admitted. The energy of suns is imparted to the waste places of space in nebulous clouds, from which new suns are born; but the givers of light and life, the organized stars, have lost something by the process; and the *loss is cumulative*; therein the argument is briefly expressed. It is immaterial how many new suns are born from nebulae, all must trace back their origin to the light giving stars. The loss of energy in these latter is irrevocable; they must go through the process of waning and decay to darkness. Their offspring, assembled near the galactic poles, may eventually take their places, in their turn only to sink to darkness, after contributing their share to newer nebulae. The number of the nebulae must steadily decrease, with the extinction of parent stars, until they cease their function of fresh star formation, on account of the loss of repulsive forces in the waning and dead

suns. Time only, stretching into eternity is necessary to complete the process, and of this, the past is quite as immeasurable as the future.

Therefore, owing to the inadequacy of the cyclic movement, from stars to nebulae and back again, for maintaining a balance in the making and unmaking of the suns, the conclusion must be drawn, either that the heavens in the past were much brighter than at present, and will steadily decrease in brightness, a proposition that postulates an origin and goal that eludes imagination, or else that the dark stars do enjoy a process of rejuvenation. The latter conclusion only is tenable.

THE REFORM OF THE CALENDAR.

RALPH. E. WILSON

During the early part of 1912 a letter was put into circulation by the Swiss minister at Washington, asking the opinion of the scientific and commercial men of this country upon a reform of the Gregorian calendar proposed by Professor L. A. Grosclaude of Geneva, Switzerland. For several centuries the correlation of the day, week, month and year, as presented in the Gregorian calendar has been unsatisfactory and many schemes of reform have been suggested. None of them, however, have met with enough favor to justify universal adoption.

The two principal inconveniences in our present calendar arise from the facts (1) that particular days of the week do not fall upon the same day of the month in successive years, thus causing needless complications in the reckoning of dates, and (2) that the variation in the dates of Easter and the preceding season causes business complications which at times become serious, especially in Europe where Catholic influences are strong. It is rather inconceivable that civilized nations, who are seeking conveniences in every line of business, should so long tolerate such a universal inconvenience as the Gregorian calendar.

In June 1910, the International Congress of Chambers of Commerce and Industrial Associations, meeting in London, resolved unanimously:

1. It is desirable to arrive at the establishment of a fixed international calendar.

2. It is desirable by international agreement to bring about a fixed date for Easter.

The Congress of French Chambers of Commerce, meeting at Brussels in August 1910, voted, again unanimously;

"The congress is of the opinion that Easter exerts an influence on the business of a large number of associations: that the variability of the date does serious harm in many cases; that it is advantageous to propose a fixed date and there are no serious objections to this even from a religious point of view; that. in consequence, it would be of great interest to reform the present calendar, called 'Gregorian', and to replace it by a new universal calendar, Grosclaude style."

These sentiments expressed by two of the leading commercial organizations of Europe serve simply to show that the business world feels the need of a calendar in which dates shall be fixed. Whether or not the need is so strongly felt in this country we cannot say, as no large commercial organization has, to our knowledge, given the subject careful consideration. It is however, clear that the fixation of dates, if it did not involve too radial a change from our present system, would facilitate calculation of interest and monthly reckonings as well as the recollections of dates of past events. The fixation of the date of easter is a question for the churches to decide and its discussion can only enter into this paper as a corollary to the fixation of all dates. According to the Encyclopedia Brittanica the objects sought in the making of the calendar are the preservation of the beginning of the year at the same distance from the solstices or equinoxes and the equable distribution of days among twelve months. The Gregorian calendar does very well in satisfying these demands if we exclude the February fiasco, but now we may add another condition, namely, that each day of the week shall occur on the same date in successive years. The problem, then, presents itself in this form; the year contains 365¼ days, is divided into twelve months and approximately fifty-two weeks of seven days each; correlate the week, month and year, so that the days of the week will fall on the same date year after year. Clearly this can only be done by the method of intercalation and in practically every one of the thirty or more reforms proposed since 1900 the intercalation has been made at the end of the year. New Year's Day is observed as a commercial holiday in nearly every part of the civilized world. If, then, we consider that day as an international holiday, known only as New Year's day, and give to it neither week name or monthly date, no serious inconvenience would be caused on the commercial world. For recording historical events the day would be known as New Year's Day 1912, 1913, or whatever the year might be, so there would be

no inconvenience in chronology. The Julian date is used extensively in astronomical work and this method of reckoning dates would not be affected in any way by the proposed reform. New Year's Day, then, would simply not go on record as a day of the week, its name would not be Monday or Thursday. It would not belong to any month, but it would be merely a holiday, set apart by itself, between December 31 are January 1.

This is the principal point in each proposed reform, for, having done away with one day as a week day, we have left 364 days or exactly 52 weeks. In this case all dates become absolutely fixed from year to year, except as Leap Year enters into consideration. There can be however, no valid objection to an extra intercalation every fourth year under the same conditions as we intercalate New Year's Day, the day to be known as Leap Day, and to belong neither to week nor month. The time for insertion of this day may present some cause for argument. The two most logical places are, at the beginning of the year immediately following New Year's Day or between the last day of June and the first of July. The first alternative would leave the distance of a day from the beginning of the year absolutely fixed, a condition very desirable in astronomical work but would also give two holidays in succession at the beginning of the year and, if we assume the year to begin on Monday and end on Sunday, there would be three days in succession upon which business would be at minimum, clearly an undesirable condition. The second alternative obviates this condition but causes a variation in the number in the days of the year. Still this is a relatively minor consideration and we may assume that with the intercalation of New Year's Day each year and Leap Day every fourth year the correlation of the week and year would be accomplished.

When we consider the correlation of the month and year another problem presents itself, as 365 is not divisible by 12. The fact that 364 is divisible by 13 has led Mr. Auguste Comte, a French philosopher, to propose the introduction of an extra month, thus giving 13 months of 28 days each or exactly four weeks. Clearly this would be the ideal calendar. Not only would each day have the same date in successive years but even in successive months each day would occur on the same date. Thus we would need but one table of 28 days, which would serve for all time, and a calendar as such would be absolutely unnecessary. There are, however, some valid objections to the insertion of an extra month. In the first place, it is rather too

radical to hope for its general adoption. Nations are naturally conservative and having come to look upon the month as a twelfth of a year, it is a question whether so radical a change in their whole reckoning of time would be welcomed. Especially would this be true in the commercial world, where salaries are paid on a monthly basis and where accounts are settled and interest calculated by quarters or halves of a year. The mere fact that 12 is divisible into so many even parts, while 13 is not, makes it highly desirable that we keep the number of months unchanged in spite of the great simplification which the introduction of an extra month would make in the calendar.

There seems to be but one other way in which to correlate exactly the week and month, and that is accomplished by making the months of unequal length, such as 28, 28, 35 days or 35, 28, 28 days, for the three months of each quarter. The objections to this plan from a commercial standpoint are evident to any thinking person. So it seems practicable to give up attempts at correlation of the week and month and to compromise on an approximate correlation of both the week and month and the month and year.

The simplest plan of reform seems to be that proposed by Professor Grosclaude, the letter concerning which prompted this article. Professor Grosclaude proposed to divide the year into four quarters containing 91 days each, 364 days in all, the intercalated New Years day making 365. As 91 is divisible by 7, there would be 13 weeks in each quarter and the week, quarter and year are exactly correlated. Dates from quarter to quarter and from year to year would then become absolutely fixed. Each quarter would be composed of three months of 30, 30 and 31 days. If we assume the year to begin on Monday, Sunday thus being the seventh day, each quarter would begin on Monday and end on Sunday. As most accounts are made up on the last work day of the month, reckonings would be greatly facilitated by this plan, inasmuch as the last work day would always be the 30th. Those months which would have 31 days would always end on Sunday, so that the 31st could never be a working day. Such a fixture of account days would be greatly appreciated in the business world. The days of the week would come on the same date in successive quarters, but not in in successive months so that the adoption of this calendar would necessitate the memorizing of three absolutely fixed tables. The memorization would, however, be exceedingly simple. Assuming the

year to begin on Monday, Sunday, for example, would occur on the 7, 14, 21 and 28 of January, April, July and October, the first months of each quarter, but on the 5, 12, 19 and 26 of the second month and on the 3, 10, 17, 24 and 30 of the last months of each quarter. If one simply remembered the date of the first Sunday of the month in the quarter, 7, 5 or 3, all other dates could be easily calculated and after a short period of usage would be unconsciously memorized.

Many minor modifications of this scheme have been proposed, such as the commencement of the year on Sunday or at the spring equinox. None of them, however, seem to present any advantages over the provisions of the Grosclaude reform, save possibly the 13 month scheme, which has already been considered. The essential points of the Grosclaude reform may be summarized as follows; the division of the year into quarters containing three months of 30, 30 and 31 days respectively, 13 weeks and 91 days; the intercalation of New Year's Day between Sunday, December 31 and Monday, January 1; and the intercalation of Leap Day every fourth year between Sunday, June 31 and Monday July 1. We would gain by the adoption of such a calendar an absolute fixation of dates from year to year and from quarter to quarter, with all the resulting advantages from a business standpoint. Above all, there would be little change from what we are used to. Our present methods of reckoning dates would not be materially changed. Everything taken into consideration, the Grosclaude scheme seems to present a maximum of advantage with a minimum of disadvantage and, when the demand for a change becomes strong enough, should meet with ready acceptance universally.

Lick Observatory,
Mt. Hamilton, Cal.

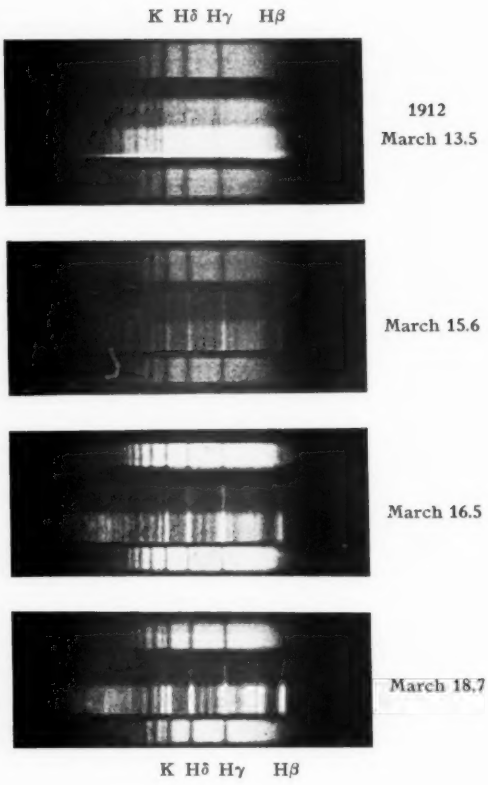
CHANGES IN THE EARLY SPECTRUM OF ENEBO'S NOVA IN GEMINI.

J. A. PARKHURST

This is a provisional report to illustrate the change from an ordinary class F5 spectrum to the regular Nova type of spectrum, which took place between March 13 and March 15, 1912.

The instrument used was a camera provided with a Zeiss doublet of ultra-violet glass, 14.5 cm aperture and 81.4 cm focal length,

PLATE VI.



CHANGES IN THE SPECTRUM OF ENEBO'S NOVA GEMINORUM AS PHOTOGRAPHED AT THE YERKES OBSERVATORY.

and an objective-prism of the same aperture and 15° angle. This instrument is described in detail in Mr. Gingrich's article on "STAR COLORS" in the December 1911 number of POPULAR ASTRONOMY. The scale of the spectra is small, only 3.0 mm from $H\beta$ to $H\theta$, therefore the finer details in the spectrum are not shown, but the general effect is given, and the changes are evident.

The spectra are broadened to the desired width by the diurnal motion, and the intensity is regulated by the number of trails. Two adjoining strips of different intensities are made to show details in parts of the Nova spectrum of different brightness. The star θ Geminorum was used to give a comparison spectrum, which was placed on each side of the Nova spectrum. The lines of the hydrogen series in the spectrum of θ (Class A2), serve to identify the lines in the Nova spectrum and to show their approximate wave-lengths. The $H\beta$ in the blue-green, barely shows on the right (the end towards the red) and the series can be traced to $H\zeta$ in the violet. The calcium K line shows just to the left of $H\epsilon$.

Spectra taken on the following dates are shown in the plate:

1912 G.M.T.	No. of trails	Exposure	Est. Mag.
March 13.5	5 and 10	75 sec.	4.0
15.6	5 and 10	75 sec.	4.8
16.5	10 and 30	200 sec.	5.2
18.7	7 and 30	200 sec.	5.2

March 13. In the spectrum of the Nova the dark hydrogen lines match the lines in the comparison spectrum in position, but are weaker. The calcium K line is relatively strong and the spectrum extends farther into the ultra violet than the spectrum of θ Geminorum. The solar G group shows faintly just to the left of $H\gamma$. For these reasons the spectrum is classed as F5 in the Harvard system (confirmed by a later telegram from Harvard). The only unusual feature is a slight tendency towards a fluted effect in the continuous spectrum.

March 15. Though the negative is weak, as the Nova had declined about 0.8 of a magnitude, the spectrum shows radical changes. Bright lines now appear on the sides of the dark hydrogen lines toward the red. The $H\beta$, though weak, can be seen. The $H\gamma$ is strong. The calcium K line also appears bright. The con-

tinuous spectrum, instead of being nearly uniform, as on March 13, is breaking up into bright and dark regions. The change to a typical Nova spectrum is therefore practically complete.

March 16. This is a strong negative and shows the lines very plainly. The changes since March 15 are in degree, rather than kind. The bright hydrogen lines have increased in relative strength, the continuous spectrum is gathered still more into bright regions, and extends farther into the ultra-violet. On the original negative it extends to wave-length 3600. On account of the change in the character of the continuous spectrum the dark hydrogen lines no longer appear, from lack of background.

March 18. The principal change is a slight increase in the relative strength of the $H\beta$ line. Visual observations show an increasing yellow color in the Nova, doubtless due to an increase in the strength of the $H\alpha$ line in the red which does not affect the plate. On the other hand, the photographic image of the Nova is relatively stronger than that of the white star θ, due to the extension of the spectrum into the violet. This phenomenon was noticed to a less extent in Nova Lacertae of 1910-11.

As far as I am aware, this is the first case in which the entire change from an absorption to an emission spectrum has been followed, at this stage in the evolution of a new star.

Yerkes Observatory, 1912, March 20.

ARCTURUS OF BOOTES.

CHARLES NEVERS HOLMES

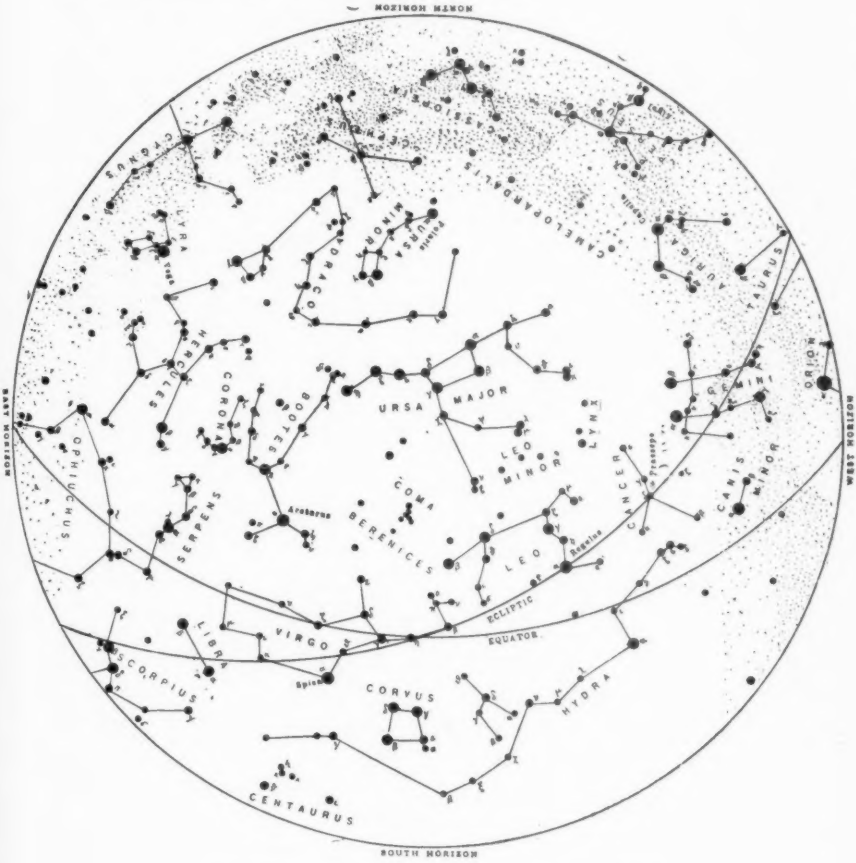
Like beacon blazing with celestial fire,
Or star-king reigning mid the suns of night
Arcturus rises over roof and spire
As grand Orion slowly fades from sight;
When queenly Vega sparkles midst her Lyre,
And Crown and Cross are gleaming high and white,
Like sleepless eye that time alone can tire,
Yon Herdsman's Jewel glitters clear and bright.

The Plymouth Inn,
Northampton, Mass.

PLANET NOTES FOR MAY, 1912.

C. H. GINGRICH.

The sun will move northward rather rapidly during the month and by the end of the month will be less than two degrees from its greatest declination north. The earth will be moving away from the sun.



THE CONSTELLATIONS AT 9:00 P. M. MAY 1, 1912.

This month will be somewhat unusual because of the fact that there will be two full moons. The phases of the moon are as follows;

Full Moon	May 1	at	4 A. M.	C. S. T.
Last Quarter	9	"	4 A. M.	"
New Moon	16	"	4 P. M.	"
First Quarter	23	"	8 A. M.	"
Full Moon	30	"	5 P. M.	"

Mercury reaches its greatest distance in miles from the sun on May 2. This feature has no special interest because it does not essentially effect the observations of that planet made from the earth. However, it is of interest that Mercury reaches its greatest angular distance from the sun on May 12. It will then be about one and three fourths hours of right ascension west of the sun. It will be several degrees south of the sun at this time. In the neighborhood of this date the planet will be visible to the naked eye near the eastern horizon just before sunrise.

Venus will be between Mercury and the sun during this month. It will be approaching the sun and probably will not be easily visible to the naked eye at any time during the month.

Mars will be moving slowly eastward but the sun will be moving more rapidly eastward, so that Mars will be lower in the west each evening at sunset. Any observations of Mars will have to be made early in the evening.

Jupiter will have a slow retrograde motion, that is, it will be moving westward instead of eastward, which is the general motion of all the planets. This motion toward the west is, however, only apparent, and is due to the motion of the earth. The actual motion of Jupiter in its orbit eastward is undisturbed. Jupiter will be in opposition on May 30. It will then be on the eastern horizon at sunset. It will, however, at this time be nearly as far south of the equator as the sun is north of the equator. Its point of rising will not differ much from that of the sun in December.

Saturn will be too near the sun all during the month for observation. It will have the same right ascension as the sun on May 14. It will also have nearly the same declination as the sun, and consequently will rise and set with the sun.

Uranus will rise in the south east before midnight.

Neptune will be lower in the west each evening at sunset but will be visible in a telescope throughout the month.

Occultations visible at Washington.

Date 1912	Star's Name	Magnitude.	IMMERSION. Washington M.T. h m	IMMERSION. Angle f'm N. °	EMERSION. Washington M.T. h m	EMERSION. Angle f'm N °	Duration h m
May 2	50 B Scorpii	6.4	8 14	115	9 17	298	1 03
4	210 B Scorpii	5.8	10 52	58	11 44	329	0 52
8	37 Capricorni	5.7	15 42	43	17 03	267	1 21
20	ω B Capricorni	5.9	9 21	35	9 35	5	0 14
20	4 Cancri	6.2	9 29	101	10 21	299	0 52
23	*l* Leonis	5.3	7 48	154	8 54	284	1 07
29	31 B Scorpii	5.4	13 10	111	14 33	281	1 23

Phenomena of Jupiter's Satellites.

Central Standard Time.

1912	h	m					h	m			
May 1	11	25	I	Oc.	Dis.	May 16	12	40	I	Tr.	In.
	14	17	I	Oc.	Re.		14	01	III	Tr.	Eg.
2	8	31	I	Sh.	In.		14	32	I	Sh.	Eg.
	9	11	I	Tr.	In.		14	53	I	Tr.	Eg.
	10	44	I	Sh.	Eg.	17	9	41	I	Ec.	Dis.
	11	24	I	Tr.	Eg.		12	12	I	Oc.	Re.
4	15	03	II	Ec.	Dis.	18	9	0	I	Sh.	Eg.
	18	54	II	Oc.	Re.		9	19	I	Tr.	Eg.
6	10	07	II	Sh.	In.	20	15	16	II	Sh.	In.
	11	18	II	Tr.	In.		15	49	II	Tr.	In.
	12	44	II	Sh.	Eg.	22	9	31	II	Ec.	Dis.
	13	57	II	Tr.	Eg.	22	12	35	II	Ec.	Dis.
8	13	19	III	Ec.	Dis.		14	25	I	Tr.	In.
	16	02	I	Oc.	Re.		14	32	III	Sh.	In.
9	8	41	III	Sh.	Eg.		15	26	III	Tr.	In'
	8	49	III	Tr.	In.	24	7	13	II	Sh.	Eg.
	10	24	I	Sh.	In.		7	33	II	Tr.	Eg.
	10	41	III	Tr.	Eg.		11	35	I	Ec.	Dis.
	10	56	I	Tr.	In.		13	56	I	Oc.	Re.
	12	38	I	Sh.	Eg.	25	8	41	I	Sh.	In.
	13	08	I	Tr.	Eg.		8	51	I	Tr.	In.
10	10	28	I	Oc.	Re.		10	54	I	Sh.	Eg.
13	12	41	II	Sh.	In.		11	93	I	Tr.	Eg.
	13	34	II	Tr.	In.	26	8	22	I	Oc.	Re.
	15	21	II	Sh.	Eg.	27	7	09	III	Oc.	Re.
	16	11	II	Tr.	Eg.	29	12	07	II	Ec.	Dis.
15	10	19	II	Oc.	Re.		14	50	II	Oc.	Re.
	15	22	I	Ec.	Dis.	31	7	07	II	Sh.	In.
16	10	34	III	Sh.	In.		7	09	II	Tr.	In.
	12	59	III	Tr.	In.		9	47	II	Tr.	Eg.
	12	08	III	Sh.	In.		9	47	II	Sh.	Eg.
	12	18	I	Sh.	In.		13	27	I	Oc.	Dis.
	12	40	III	Sh.	Eg.		15	39	I	Oc.	Re.

Note.—In., denotes ingress; Eg., egress; Dis., disappearance; Re., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

VARIABLE STARS.

Approximate Magnitudes of Variable Stars on Mar. 1, 1912.

[Communicated by the Director of Harvard College Observatory, Cambridge, Mass.]

Name.	R. A. 1900. h	m	Decl. 1900. °	′	Magn.	Name.	R.A. 1900. h	m	Decl. 1900. °	′	Magn.
X Androm.	0	10.8	+46	27	<12	RV Cassiop.	0	47.1	+46	53	9.1
T Androm.		17.2	+26	26	10.6*d*	W Cassiop.		49.0	+58	1	8.9
T Cassiop.		17.8	+55	14	10.9 *i*	U Androm.	1	9.8	+40	11	9.6 *i*
R Androm.		18.8	+38	1	8.0*d*	— Androm.		10.4	+41	12	12.0*d*
Y Cephei		31.3	+79	48	12.6 *i*	S Cassiop.		12.3	+72	5	10.0*d*
U Cassiop.		40.8	+47	43	10.9*d*	S Piscium		12.4	+ 8	24	<12
RW Androm.		41.9	+32	8	11.0*d*	RZ Persei		23.6	+50	20	13.9
V Androm.		44.6	+35	6	<11	R Piscium		25.5	+ 2	22	8.6*d*
RR Androm.		45.9	+33	50	9.1	RU Androm.		32.8	+38	10	13.0

Approximate Magnitudes of Variable Stars on Mar. 1, 1912.

Continued.

Name.	R. A. 1900. h	m	Decl. 1900. °	′	Magn.	Name.	R. A. 1900. h	m	Decl. 1900. °	′	Magn.
Y Androm.	1	33.7	+38	50	8.4	R Can. Min.	7	3.2	+10	11	8.8
X Cassiop.		49.8	+58	46	11.2	RR Monoc.		12.4	+ 1	17	11.8*d*
R Arietis	2	10.4	+24	35	7.9	S Can. Min.		27.3	+ 8	32	9.0
W Androm.		11.2	+43	50	10.3*d*	U Can. Min.		35.9	+ 8	37	<12
Z Cephei		12.8	+81	13	<13	R Cancri	8	11.0	+12	2	10.5
o Ceti		14.3	− 3	26	8.7 *i*	V Cancri		16.0	+17	36	<10
S Persei		15.7	+58	8	12.0	RT Hydrae		24.7	− 5	59	7.7
R Ceti		20.9	− 0	38	9.0	U Cancri		30.0	+19	14	<14
RR Persei		21.7	+50	49	<14	X Urs Maj.		33.7	+50	30	<12
U Ceti		28.9	−13	35	9.3	S Hydrae		48.4	+ 3	27	<10
RR Cephei		29.4	+80	42	12.6	T Hydrae		50.8	− 8	46	9.4*d*
R Triang.		31.0	+33	50	11.1	T Cancri		51.0	+20	14	9.3
T Arietis		42.8	+17	6	9.1	V Urs. Maj.	9	1.2	+51	31	10.6
W Persei		43.2	+56	34	10.1	W Cancri		4.0	+25	39	10.5
U Arietis	3	5.5	+14	25	8.5	X Hydrae		30.7	−14	15	10.1
X Ceti		14.3	− 1	26	10.5*d*	Y Draconis		31.1	+78	18	11.1
RT Persei		16,7	+46	12	10.0	R Leo. Min.		39.6	+34	58	9.0*d*
Y Persei		20.9	+43	50	9.4	RR Hydrae		40.4	−23	34	<12
R Persei		23.7	+35	20	<13	— Leo. Min.		42.6	+33	45	9.9
SS Tauri		31.4	+ 5	2	<12	X Leonis		45.6	+12	21	<11
RW Tauri		57.8	+27	51	<11	R Leonis		42.2	+11	54	8.1 *i*
R Tauri	4	22.8	+ 9	56	10.7*d*	R Urs. Maj.	10	37.6	+69	18	11.4*d*
W Tauri		22.2	+15	49	11 5*d*	V Hydrae		46.8	−20	43	8.0
S Tauri		23.7	+ 9	44	10.2	W Leonis		48.4	−14	15	<13
T Camelop.		30.4	+65	57	8.9	S Leonis	11	5.7	+ 6	0	<12
RX Tauri		32.8	+ 8	9	11.6 *i*	RU Urs. Maj.		36.4	+39	2	9.1*d*
— Tauri		32.8	+ 8	9	<12	X Virginis		56.7	− 6	38	10.2
X Camelop.		32.6	+74	56	12.9	T Virginis	12	9.5	− 5	29	<11
R Orionis		53.6	+ 7	59	9.4	R Corvi		14.4	−18	42	10.0
R Leporis		55.0	−14	57	7.5	SS Virginis		20.1	+ 1	19	<11
V Orionis	5	0.8	+ 3	58	11.3	T Can. Ven.		25.2	+32	3	<12
T Leporis		0.6	−22	2	11.6	Y Virginis		28.7	− 3	52	<10
R Aurigae		9.2	+53	28	8.7	T Urs. Maj.		31.8	+60	2	7.9 *i*
W Aurigae		20.1	+36	49	<12	RS Urs. Maj.		34.4	+59	2	<13
T Aurigae		25.6	+30	22	10.6	S Urs. Maj.		39.6	+61	38	10.9 *i*
S Camelop.		30.2	+68	45	8.0	U Virginis		46.0	+ 6	6	<10
U Aurigae		35.6	+31	59	8.7	RV Virginis	13	2.7	−12	38	<11
SV Tauri		45.8	+28	5	9.7	W Virginis		20.9	− 2	52	9.5
SU Tauri		43.2	+19	2	9.5	V Virginis		22.6	− 2	39	9.8
Z Tauri		46.7	+15	46	<12	R Hydrae		24.2	−22	46	6.5
U Orionis		49.9	+20	10	10.5	S Virginis		27.8	− 6	41	10.3
V Camelop.		49.4	+74	30	12.2	RV Urs. Maj.		29.4	+54	31	10.5
Z Aurigae		53.6	+53	18	10.6	T Urs. Min.		32.6	+73	56	11.4 *i*
RW Gemin.		55.4	+23	8	9.5	R Can. Ven.		44.6	+40	2	12.1
RZ Gemin.		56 6	+32	15	9.7	Z Boötis	14	1.7	+13	59	<12
X Aurigae	6	4.4	+50	15	11.0	U Urs. Min.		15.1	+67	15	10.4
V Monoc.		17.7	− 2	9	11.6	S Boötis		19.5	+54	16	10.0*d*
U Lyncis		31.8	+59	57	12.7	RS Virginis		22.3	+ 5	8	<11
S Lyncis		35.9	+58	0	13.3	V Boötis		25.7	+39	18	8.0
X Gemin.		40.7	+30	23	<11	R Camelop.		25.1	+84	17	10.3*d*
RX Gemin.		43.6	+33	21	9.0	R Boötis		32.8	+27	10	9.0
W Monoc.		47.5	− 7	2	11.5	RT Librae	15	0.8	−18	21	11.4
RU Monoc.		49.4	− 7	28	<11	Y Librae		6.4	− 5	38	<11
Y Monoc.		51.3	+11	22	9.3	S Librae		15.6	−20	2	10.1
R Lyncis		53.0	+55	28	8.7*d*	S Serpentis		17.0	+14	40	<10
RS Gemin		55.2	+30	40	12.0	RU Librae		27.7	−14	59	11.7
V Can. Min.	7	1.5	+ 9	2	<12	U Librae		36.2	−20	52	<10
R Gemin.		1.3	+22	52	<11	— Librae		36.2	−20	26	9.3

Approximate Magnitudes of Variable Stars on Mar. 1, 1912—Con.

Name.	R. A. 1900. h m	Decl. 1900. ° ′	Magn.	Name.	R.A. 1900 h m	Decl. 1900 ° ′	Magn.
R Cor. Bor.	15 44.4	+28 28	7.6	RT Cygni	19 40.8	+48 32	7.3 *i*
X Cor. Bor.	45.2	+36 35	12.7*d*	TU Cygni	43.3	+48 49	10.8 *i*
Z Cor.Bor.	52.2	+29 32	11.8	X Cygni	46.7	+32 40	<11
RZ Scorpii	58.6	−23 50	8.5	Z Cygni	58.6	+49 46	<12
Z Scorpii	16 0.1	−21 28	<12	RS Cygni	20 9.8	+38 28	8.3
U Serpentis	2.5	+10 12	8.8	R Delphini	10.1	+ 8 47	<11
RU Herculis	6.0	+25 20	11.7	V Sagittae	15.8	+20 47	12.0
W Cor.Bor.	11.8	+38 3	11.5*d*	U Cygni	16.5	+47 35	6.9
R Draconis	32.4	+66 58	7.7	ST Cygni	29.9	+54 38	9.9 *i*
RV Herculis	56.8	+31 22	<11	X Cephei	21 3.6	+82 40	<13
R Ophiuchi	17 2.0	−15 58	7.0	T Cephei	8.2	+68 5	10.7
V Draconis	56.3	+54 53	11.7	S Cephei	36.5	+78 10	8.4 *i*
T Herculis	18 5.3	+31 0	11.3	S Lacertae	22 24.6	+39 48	13.2
W Draconis	5.4	+65 56	<13	R Lacertae	38.8	+41 51	<13
X Draconis	6.8	+66 8	11.0	RW Pegasi	59.2	+14 46	<12
SV Draconis	31.2	+49 18	13.0	V Cassiop.	23 7.4	+59 8	8.8*d*
RY Lyrae	41.2	+34 34	13.0	W Pegasi	14.8	+25 44	<11
Z Lyrae	56.0	+34 49	<13	S Pegasi	15.5	+ 8 22	9.4*d*
V Lyrae	19 5.2	+29 30	10.2	ST Androm.	33.8	+35 13	9.9*d*
S Lyrae	9.1	+25 50	<14	Z Cassiop.	39.7	+56 2	<13
U Draconis	9.9	+67 7	13.5	RR Cassiop.	50.7	+53 8	<13
TZ Cygni	13.4	+50 0	10.5	R Cassiop.	53.3	+50 50	<13
U Lyrae	16.6	+37 42	11.7	Y Cassiop.	58.2	+55 7	13.8
R Cygni	34.1	+49 58	9.8*d*	SV Androm.	59.2	+39 33	8.7

The letter *i* denotes that the light is increasing; the letter *d*, that the light is decreasing; the sign <, that the variable is fainter than the appended magnitude. The above magnitudes have been compiled at the Harvard College Observatory from observations made by the following observers:— T. C. H. Bouton, —Cowan, B. Ferrall, C. E. Furness, Edward Gray, M. Harwood, F. E. Hathorn, C. J. Hudson, M. W. Jacobs, Jr., W. T. Olcott, P. G. O'Reilly, J. Schoolcraft, P. R.Sutton, H. M. Swartz, David Todd, H.W. Vrooman, I. E. Woods, and A.S. Young.

Minima of Variable Stars of the Algol Type.

[Calculated by Mary H. Wilson at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard 6^h, etc.

Star	R. A. 1900 h m	Decl. 1900 ° ′	Magnitude	Approx. Period d h	Greenwich mean times of minima in **May** 1912. d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.6					
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	6 20;	12 19;	24 16;	30 15	
U Cephei	0 53.4	+81 20	7.1— 9.2	2 11.8	4 2;	9 1;	19 1;	29 0	
Z Persei	2 33.7	+41 46	9.4—12.	3 01.4	1 15;	13 20;	19 23;	26 2	
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	4 16;	11 13;	18 9;	25 6	
RZ Cassiop.	39.9	+69 13	6.4— 7.8	1 04.7	3 0;	14 23;	20 23;	26 22	
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	2 18;	13 8;	23 23;	29 6	
RX Cephei	2 58.8	+67 11	8.6— 9.1	32 07.6		24 1			
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	6 0;	11 18;	23 5;	28 23	
RT Persei	16.7	+46 12	9. —11.	0 20.4	2 16;	12 21;	23 2;	28 4	
λ Tauri	55.1	+12 12	3.4— 4.5	3 22.9	7 7;	15 4;	23 2;	30 24	
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	4 1;	15 3;	20 16;	31 17	
RV Persei	4 04.2	+33 59	10.6—12.8	1 23.4	4 11:	10 10;	22 6;	28 4	
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	6 18;	19 23			
RS Cephei	4 48.6	+80 06	9.5—12.2	12 10.1	2 3;	14 13;	26 23		

Minima of Variable Stars of the Algol Type.—Continued.

Star	R. A. 1900 h m	Decl. 1900 ° ′	Magnitude	Approx. Period d h	Greenwich mean times of minima in May 1912. d h	d h	d h	d h
RY Aurigæ	5 11.5	+38 13	10.7—11.7	2 17.5	1 1;	11 23;	22 20;	28 7
RZ Aurigæ	42.9	+31 40	10.6—13.3	3 00.3	4 15;	10 16;	22 17;	28 17
SV Gemin;	54.6	+24 28	9.8—<11	4 00.2	4 23;	12 24;	21 0;	29 0
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	3 6;	14 17;	26 4;	31 21
U Columbæ	6 11.2	−33 03	9.4—10.2	2 19.2	8 19;	14 10;	25 15;	31 5
SX Gemin.	22.	+20 37	10.8—11.5	1 08.8	5 20;	11 7;	22 6;	27 17
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	2 17;	10 8;	17 23;	25 14
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	9 16;	21 21		
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	4 20;	15 14;	26 8;	31 17
R Canis Maj.	7 14.9	−16 12	5.9— 6.7	1 03.3	1 18;	13 2;	24 11;	30 3
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	8 7;	17 15;	26 22	
Y Camelop	27.6	+76 17	9.5—12.	3 07.3	9 14;	16 5;	22 19;	29 10
RR Puppis	43.5	−41 08	9.5—	6 10.3	6 9;	12 20;	19 6;	25 16
V Puppis	7 55.4	−48 58	4. — 5.	1 10.9	7 2;	14 9;	21 15;	28 22
X Carinæ	8 29.1	−58 53	7.8— 8.9	0 13.0	1 21;	12 17;	23 13;	28 23
S Cancri	8 38.2	+19 24	8. —10.	9 11.6	1 0;	10 12;	19 23;	29 11
S Velorum	9 29.5	−44 46	7.8— 9.5	5 22.4	1 18;	13 15;	25 11;	31 10
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	6 21;	15 8;	23 18	
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	4 14;	13 21;	23 3	
SS Carinæ	10 54.2	−61 23	12.2—12.8	3 07.2	4 8;	10 23;	24 4;	30 18
RW Urs. Maj	11 35.4	+52 34	9.3—10.3	7 07.9	6 16;	14 0;	21 8;	28 15
Z Draconis	11 40.6	+72 49	9.5—12.5	1 08.6	7 5;	14 0;	20 19;	27 14
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	7 24;	15 10;	22 21;	30 7
δ Libræ	14 55.6	− 8 07	5. — 6.7	2 07.9	5 21;	12 21;	19 20;	26 20
TW Draconis	15 32.4	+64 14	7.0— 8.9	2 19.4	6 12;	14 22;	23 8;	31 18
U Coronæ	15 14.1	+32 01	7.8— 9.0	3 10.9	7 12;	14 9;	21 7;	28 5
SX Ophiuchi	16 12.6	− 6 25	10.5—11.2	2 01.5	4 23;	11 4;	23 13;	29 17
SW Ophiuchi	16 11.1	− 6 44	9.2—10.	2 10.7	5 15;	12 23;	20 7;	27 16
R Aræ	16 31.1	−56 48	6.7— 8.	4 10.2	7 1;	15 22;	24 18	
TT Herculis	16 49.9	+17 00	8.9— 9.5	20 18.1		20 18;		
TU Herculis	17 09.8	+30 50	9.5—12.	2 06.4	4 11;	11 6;	24 20;	31 16
U Ophiuchi	11.5	+ 1 19	6. — 6.7	0 20.1	6 15;	15 0;	23 9;	31 19
SZ Herculis	36.0	+33 01	9 5—10.3	0 19.6	3 0;	11 5;	19 9;	27 13
Z Herculis	17 53.6	+15 09	6.7— 8.0	3 23.8	7 16;	15 15;	23 15;	31 15
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	2 24;	13 8;	23 16;	28 20
RS Sagittarii	11.0	−34 08	6.7— 7.8	2 10.0	5 9;	12 15;	19 20;	27 2
V Serpentis	11.1	−15 34	9.5—	3 10.9	1 7;	8 5;	25 2	
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	2 7;	13 8;	24 8;	29 20
RZ Herculis	26.0	+12 32	7.8— 8.0	0 21 3	5 18;	14 16;	23 13	
SX Sagittarii	18 39.7	−30 36	8.6— 9.4	2 01.8	5 22;	12 3;	24 14;	30 20
RR Draconis	40.8	+62 34	9.3—13.	2 19.9	9 5;	17 16;	26 4	
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	6 11;	13 11;	20 2;	26 16
U Scuti	18 48.9	−12 44	9.0— 9.8	0 22.9	5 20;	15 9;	24 22	
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.5	6 0;	15 11;	24 22	
RV Lyræ	12.5	+32 15	11. —13.	3 14.4	7 18;	14 22;	22 3;	29 8
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	8 20;	17 19;	26 18	
U Sagittæ	14.4	+19 26	6.7— 9.0	3 09.1	7 15;	14 10;	21 4;	27 22
Z Vulpec.	17.5	+25 23	7.3— 8 5	2 10.9	2 1;	9 9;	24 3;	31 12
TT Lyræ	24.3	+41 30	9.0<11.0	5 05.8	5 14;	16 1;	21 7;	31 19
SY Cygni	19 42.7	+32 28	10. —12.	6 00.2	4 21;	10 21;	22 22;	28 22
WW Cygni	20 00.6	+41 18	9.5—12.5	3 07.6	6 7;	12 23;	19 14;	26 5
SW Cygni	03.8	+46 01	9. —12.	4 13.8	1 14;	10 18;	19 21;	29 1
VW Cygni	11.4	+34 12	9.5—11.5	8 10.3	3 22;	12 9;	20 19;	29 5
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	5 9;	12 4;	18 23;	25 17
UW Cygni	19.6	+42 55	10.5—13.	3 10.8	4 23;	11 20;	18 18;	25 16
W Delphini	33.1	+17 56	9.5—11.5	4 19.4	6 7;	15 22;	25 13	
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	3 9;	12 14;	21 19;	31 0
Y Cygni	48.1	+34 17	7. — 8.	1 12.0	1 2;	8 14;	23 13;	31 1
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	1 16;	11 18;	21 21;	31 23

Minima of Variable Stars of the Algol Type.—Continued.

Star	R. A. 1900 h m	Decl. 1900 ° ′	Magnitude	Approx. Period d h	Greenwich mean times of minima in May 1912. d h; d h; d h; d h
VV Cygni	21 02.3	+45 23	11. —14.	1 11.4	7 11; 14 20; 22 6; 29 15
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	9 18; 19 10; 29 3
UZ Cygni	55.2	+43 52	9. —11.5	31 07.3	8 11
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	5 11; 15 14; 25 18; 30 19
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	5 11; 15 19; 26 4; 31 9
TT Androm	23 08.7	+45 36	10.5—11.3	2 18.3	6 9; 14 16; 22 23; 31 6
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	3 14; 11 3; 18 16; 26 5
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	4 21; 13 3; 21 9; 29 14

Maxima of Variable Stars of Short Period not of the Algol Type.

[Calculated by Wallace F. Johnson at Goodsell Observatory]

Given to the nearest hour in Greenwich mean time. To obtain eastern standard time subtract 5^h; Central standard time 6^h etc. An * following the name of a star signifies that for that star times of minima instead of maxima are given.

Star	R. A. 1900 h m	Decl. 1900 ° ′	Magnitude	Approx. Period d h	Greenwich mean times of maxima in May 1912. d h; d h; d h; d h
SX Cassiop.	0 05.5	+54 20	8.6— 9·4	36 13.7	
SY Cassiop.	9.8	+57 52	9 3— 9.9	4 1.7	8 12; 16 15; 24 19
RT Sculptor.*	0 31.5	−26 13	9.6—10.5	0 12.3	4 9; 9 12; 19 18; 29 23
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	2 12; 8 1; 19 3; 30 4
RW Cassiop.	1 30.7	+57 15	8.6— 9.4	14 19 2	11 2; 25 22
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	4 14; 10 13; 22 10; 28 9
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	1 17; 7 13; 19 6; 30 23
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	6 1; 12 3; 24 6; 30 8
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	14 0; 30 0
SX Persei	4 10.2	+41 29	10.3—11.0	4 07.1	4 6; 12 20; 21 10; 30 0
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	10 7; 21 10
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	1 16; 13 7; 24 22
TT Aurigæ*	5 02.8	+39 27	7.8— 8.7	0 16.0	2 17; 9 9; 22 17; 29 8
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	2 22; 9 1; 21 7; 27 10
SYAurigæ	05.5	+42 42	9.0— 9.7	10 03.3	3 7; 13 10; 23 13
Y Aurigæ	21.5	+42 21	9. —	3 20.6	3 15; 11 8; 19 1; 26 28
RVTauri*	45.8	+28 05	9.4—11.0	2 04.0	5 10; 11 23; 24 23; 31 11
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	6 9; 11 22; 22 23; 28 12
RS Orionis	6 16.5	+14 43	7·8— 8.5	7 13.4	5 7; 12 20; 20 10; 27 23
T Monoc.	19.8	+ 7 08	6. — 8.	27 00.3	24 3
RZ Camelop	23.7	+67 06	11.0—12.8	0 11.5	2 9; 12 0; 21 14; 31 5
W Gemin.	29.2	+15 24	6.8— 7.6	7 22.0	4 22; 12 20; 20 18; 28 16
ζ Gemin.	6 58.2	+20 43	3.7— 4.5	10 03.7	2 5; 12 8; 22 12
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	12 5
RR Gemin.	7 15.2	+31 04	9.7—10.6	0 09.5	1 19; 9 18; 17 16; 25 15
V Carinæ	8 26.7	−59 47	7.2— 8.0	6 16.7	2 21; 9 14; 22 23; 29 16
T Velorum	8 34.4	−47 01	7.5— 8.5	4 15.3	4 11; 9 2; 18 9; 27 15
W Carinæ	9 19.2	−55 32	7.5— 8.5	4 08.9	5 1; 13 19; 22 13; 31 6
S Antliæ*	27.9	−28 11	6.7— 7.8	0 07.8	3 12; 10 0; 22 23; 29 11
W Ursæ Maj.	9 36.7	+56 24	8.	0 04.0	2 15; 9 8; 22 16; 29 8
RR Leonis	10 02.1	+24 03	9.1—10.0	0 10.9	4 5; 11 0; 24 14; 31 9
ST Ursæ Maj.*	11 22.4	+45 44	6.7— 7.2	8 19.2	8 10; 17 5; 26 0
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	5 17; 12 8; 18 22; 25 13

Maxima of Variable Stars of Short Period not of the Algol Type.

Continued,

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean time of maxima in May 1912.
	h m	° ′		d h	d h d h d h d h
S Muscae	12 07.4	−69 36	6.5— 7.3	9 15.8	6 8; 16 0; 25 16
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	1 11; 7 4; 18 14; 29 23
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	2 10; 9 4; 22 15; 29 9
R Crucis	18.1	−61 04	6.8— 8.0	5 19.8	1 4; 7 0; 18 16; 30 7
S Crucis	48.4	−57 53	6.6— 7.8	4 16.6	1 13; 10 22; 20 7; 29 16
RZ Centauri	12 55.6	−64 05	8.5— 8.9	0 22.5	3 2; 10 14; 18 2; 25 14
W Virginis	13 20.9	− 2 52	9.0—10.0	17 06.5	7 8; 24 14;
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	2 9; 9 10; 23 11; 30 11
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	7 15; 15 20; 24 1
V Centauri	25.4	−56 27	6.7— 7.6	5 11.9	2 1; 7 13; 18 13; 29 13
RS Bootis	29.3	+32 11	8.9—10.	0 09.1	3 10; 10 23; 18 12; 26 2
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	3 3; 10 13; 17 23; 25 9
RTriang.Austr	15 10.8	−66 08	6.7— 7.7	3 09.3	6 12; 13 7; 20 1; 26 20
STriang.Austr	15 52.2	−63 29	6.5— 7.5	6 07.8	2 11; 8 19; 21 10; 27 18
S Normæ	16 10.6	−57 39	6.5— 7.4	9 18.1	2 9; 12 3; 21 21; 31 15
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	1 13; 10 9; 19 5; 28 2
RV Scorpii	16 51.8	−33 27	6.8— 7.6	6 01.5	1 5; 7 6; 19 9; 31 12
u Herculis*	17 13.6	+33 12	5.1— 5.6	2 01.2	1 18; 7 21; 20 6; 26 8
RV Ophiuchi*	17 29.8	+ 7 19	9.—< 11	3 16.5	2 0; 9 9; 24 3; 31 12
X Sagittarii	41.3	−27 48	4.0— 6.0	7 00.3	5 13; 12 13; 19 13; 26 14
Y Ophiuchi	47.3	− 6 07	6.2— 7.0	17 02.9	8 16; 25 19
W Sagittarii	17 58.6	−29 35	4.8— 5.8	7 14.3	4 5; 11 19; 19 9; 26 23
Y Sagittarii	18 15.5	−18 54	5.8— 6.6	5 18.6	5 0; 10 19; 22 8; 28 2
U Sagittarii	26.0	−19 12	7.0— 8.3	6 17.9	5 6; 12 0; 18 18; 25 12
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	1 20; 12 4; 22 13
Y Lyrae	34.2	+43 52	10.5—12.	0 12.1	1 10; 7 11; 19 12; 31 14
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	6 1; 11 3; 21 9; 31 14
RT Scuti	44.1	−10 30	9.1— 9.7	0 11.9	5 6; 10 5; 20 3; 30 1
β Lyrae *	46.4	+33 15	3.4— 4.5	12 21.8	4 9; 17 7; 30 5
κ Pavonis	18 46.9	−67 22	4.0— 5.5	9 02.2	6 18; 15 20; 24 22
U Aquilae	19 24.0	− 7 15	6.4— 7.1	7 00.6	3 3; 10 3; 24 5; 31 5
XZ Cygni	30.4	+56 10	8.7— 9.3	0 11.2	1 15; 10 23; 20 7; 29 15
U Vulpec.	32.2	+20 07	6.9— 7.6	7 23.5	7 22; 15 22; 23 21; 31 21
SU Cygni	40.8	+29 01	6.6— 7.4	3 20.3	2 4; 9 20; 17 13; 25 5
η Aquilae	47.4	+ 0 45	3.5— 4.7	7 04.2	4 18; 11 22; 19 2; 26 7
S Sagittae	51.5	+16 22	5.6— 6.4	8 09 2	6 12; 14 21; 23 6; 31 15
X Vulpec.	19 53.3	+26 17	8.5— 9.1	6 07.7	1 2; 7 10; 20 1; 26 9
XX Cygni	20 01.3	+58 40	10.5—11.5	0 03.2	3 3; 9 21; 23 9; 30 2
V Vulpec. *	32.3	+26 15	8.0— 9.0	37 19 0	24 23
X Cygni	39.5	+35 14	6.4— 7.7	16 09 3	7 15; 21 1;
T Vulpec.	47.2	+27 52	5.5— 6.5	4 10 5	4 21; 13 18; 22 15; 31 12
WZ Cygni *	49.3	+38 27	9.8—10.8	0 14.0	1 14; 7 10; 19 3; 30 20
WY Cygni	52.3	+30 03	9.5—10.3	0 13.5	6 7; 11 22; 23 3; 28 17
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	4 4; 13 3; 22 2; 31 0
TX Cygni	20 56.4	+42 12	8 5— 9.7	14 17.4	8 15; 23 8
VY Cygni	21 00.4	+39 34	8.9— 9.5	7 20.6	7 9; 15 5; 23 2; 30 23
VZ Cygni	21 47.7	+42 40	8.4— 9.2	4 20.7	4 18; 9 14; 19 8; 29 1
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.6	4 14; 13 6; 21 21; 30 13
δ Cephei	25.5	+57 54	3.7— 4.9	5 08.8	3 1; 8 10; 19 4; 29 21
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	7 19; 18 16; 29 13
RR Lacertae	37.5	+55 55	8 5— 9.2	6 10.1	1 21; 8 7; 21 3; 27 13
V Lacertae	44.5	+55 48	8.2— 8.9	4 23.6	3 20; 8 19; 18 19; 28 18
X Lacertae *	22 45.0	+55 54	8.2— 8.6	5 10.6	1 10; 6 21; 17 18; 28 15
SW Cassiop.	23 03.7	+58 12	9.2— 9.7	5 10.6	3 3; 8 13; 19 10; 30 7
RS Cassiop.	32.6	+61 52	9.1—10.0	6 07.1	7 3; 13 10; 19 17; 26 0
RY Cassiop.	47.2	+58 11	9.2—10.0	12 03.4	5 2; 17 6; 29 9
U Pegasi	23 52.9	+15 24	9.0— 9.7	0 04.5	1 4; 8 16; 23 16; 31 4

Minima of Algol Occur Early.—Mr. Judson W. Brush of Cedar Rapids, Ia., calls attention to the fact that the minima of Algol occur about 3^h earlier than the times indicated in our tables. This is due to a progressive change in the elements of the star's variation, which has been neglected in the computations.

New Variable 1.1912 Lyræ.—The first new variable for this year is announced by Professor W. Ceraski in *A. N.* 4553, discovered by Mme. L. Ceraski upon the Moscow photographs. Its position for 1900.0 is

$$\alpha = 18^h\ 18^m\ 00^s \qquad \delta = +30^\circ\ 23.$$

From the discussion of 19 plates taken in the years 1899-1911 Mr. S. Blajko concludes that the star varies from 11^m to $<12\frac{1}{2}^m$ and that the period is probably long.

New Variable 2.1912 Lyræ.—In *A. N.* 4554 Mr. W. Luther of Düsseldorf announces the variability of the star BD $+6^\circ$ 975 ($9^m.0$). On December 18, 1911, it was missing, while its neighbors of magnitude 8.9 and 9.5 were present. On January 17, 1912, it was of about magnitude 10.4. The position for 1900.0 is

$$\alpha = 5^h\ 32^m\ 34^s.2 \qquad \delta = 6^\circ\ 15'\ 5''.6.$$

According to Professor Küstner the original records at Bonn give magnitude 9.5 on Jan. 8, 1851, and 8.5 on Jan. 22, 1854.

New Variable 3.1912 Coronæ Borealis.—In *A. N.* 4557 Professor W. Ceraski announces a new variable found by Mme. L. Ceraski in Corona Borealis. The position for 1900.0 is

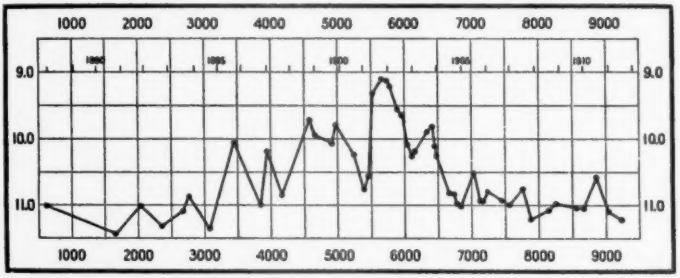
$$\alpha = 16^h\ 15^m\ 21^s \qquad \delta = +29^\circ\ 57'$$

From fifteen photographs in 1907-1911 it seems that the star ranges in brightness between magnitudes about 9.5 and 10.5.

Three Missing Stars of the BD. Catalogue.—In *A. N.* 4556 Mr. Luizet of Lyons, France, calls attention to the fact that on Aug. 26 last the three stars BD $+12^\circ$ 4991, $+12^\circ$ 4895 and $+13^\circ$ 5119, all rated at magnitude 9.5, were invisible with the equatorial coudé of $0^m.32$ aperture. Professor Küstner of Bonn, looking up the original observations finds them correctly reduced, and all three stars observed twice. He also found the stars missing from the sky on February 7, 1912. It seems remarkable that three stars so close together should be found variable and invisible at the same time, and equally improbable the three double observations should all be wrong.

Variable Stars 1905-1909.—Memoirs of the British Astronomical Association, Vol. XVIII, consists of a 306 page report of the section for the observation of variable stars. The major part of the report consists of the individual observations of variable stars by the various observers. It contains therefore much valuable material for the study of the light changes of these stars.

The Light Curve of Z Andromedæ.—The accompanying diagram of the light curve of Z Andromedæ is given in circular No. 168 of the Harvard College Observatory. This curve represents the observed variations of the star on 273 photographic plates taken in the interval from 1887, Nov. 30 to 1911 July 12. The star is BD + 48° 4093, magnitude 9.5, and its variability was



THE LIGHT CURVE OF Z ANDROMEDÆ.

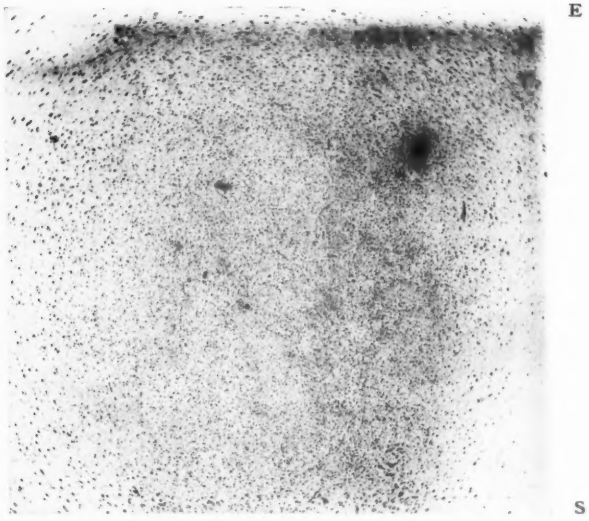
discovered by Mrs. Fleming in 1901. From the diagram it appears that the light curve is very peculiar, and unlike that of any other star so far observed. The numbers on the upper and lower margins of the diagram indicate intervals of 1000 days, and the numbers at the right and left the magnitude of the star. The principal outburst was in 1901 when the star attained the magnitude 9.2. At its lowest it was of about magnitude 11.5. The spectrum is unlike that of variable stars of long period and resembles that of several new stars.

A New Star (Nova Geminorum No. 2).—By cablegram from Kiel, Germany, to Harvard Collge Observatory it was announced on March 13 that a new star of the fourth magnitude had been discovered by Enebo, of Dombaas, Norway, in the constellation Gemini, near the star Theta. Harvard Astron-

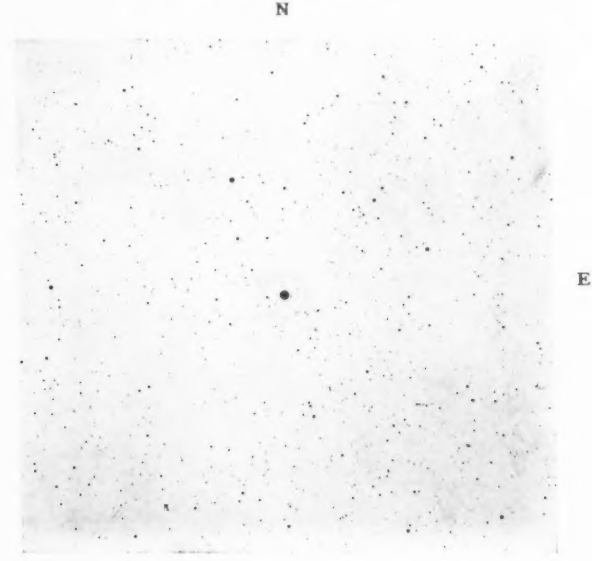
PLACE OF ENEBO'S NOVA.

omical Bulletin No. 486, issued on March 13, states that "the new star Nova Geminorum No. 2, discovered last night by Enebo, is confirmed by two photographs taken here March 11, 1912. Fifth magnitude. It is not visible on two plates taken here March 10, 1912, although stars of the eleventh magnitude are shown. Its position for 1855 is R. A. $6^h\ 45^m.5$, Dec. + 32° 17. It is about 1° 51′ south of θ (theta) Geminorum."

PLATE VII.



With the 2-inch Darlot Lens.



With the 8-inch Refractor.

PHOTOGRAPHS OF THE REGION ABOUT NOVA GEMINORUM NO. 2.

March 14, 1912, 10:35 to 11:35 Central Standard Time,
by H. C. Wilson.

It thus appears that the star rose suddenly in brightness (from below the eleventh magnitude on March 10 to the fifth magnitude on March 11), as is characteristic of novæ. On the twelfth it had reached the fourth magnitude and on March fourteenth its brightness was greater that of Theta Geminorum, or about magnitude 3.5.

The first observation of the star at Northfield was obtained on March 14 at 8 p. m. C.S.T., when it was picked up immediately with the naked eye, being slightly brighter than θ Geminorum. Later in the evening it was examined with the telescope and found to be almost white in color, almost exactly like the star θ. The photographs, Plate VII, taken with the 8-inch refractor and with the 2-inch Darlot lens, both show that photographically as well as visually the nova was the equal of θ. In these photographs the directions east and west are reversed from their directions in the sky. The nova is near the center in both pictures and the bright star in the upper right hand portion of the first picture is Castor.

On March 15 at 8:15 p.m. the star was much fainter and was barely visible to the naked eye. March 17 and 18 it was very difficult to see and on March 19 it was invisible to the unaided eye. Its color changed as well as its brightness. On March 18, as examined with the five-inch finder and the 16-inch telescope, the star was strong in red color, whereas on the 14th it had been white.

The Harvard Bulletins given below indicate that a marked change occurred in the spectrum. On the thirteenth it showed only dark lines, closely resembling the spectrum of the F type stars, like Procyon. On the fourteenth it was more like the spectrum of the Nova Persei No. 2, soon after that star appeared, with bright lines on the edge toward the red of the dark hydrogen lines.

The following estimates of brightness have been made by the writer (H. C. Wilson) with the naked eye and with the aid of a pair of 2-inch field-glasses:

March 14	8:00	C.S.T.	3.5
	10:00	"	3.6
	11:00	"	3.6
	12:30	"	3.7
15	8:15	"	4.7
18	8:20	"	5.3
	11:00	"	5.3
19	9:35	"	5.4
21	9.25	"	5.4
22	10.27	"	5.1
23	7.30	"	4.9
	10.00	"	4.8

Enebo's Nova was observed at the Harvard Observatory last night visually and photographically. The visual magnitude was about 3.8. Photographs giving chart images and spectra, were obtained with several instruments. The spectrum is unlike that of other novae, the hydrogen lines being well defined and dark, instead of bright. The spectrum closely resembles that of Class F5, of which α Canis Minoris is a typical star.

EDWARD C. PICKERING.

Astronomical Bulletin No. 487.
Harvard College Observatory,
Cambridge, Mass., Mar. 14, 1912.

Enebo's Nova.—Hussey telegraphs "Enebo Nova March thirteen and seven tenths, Curtiss finds visual magnitude three and nine tenths, spectrum usual Nova maximum type closely resembling earlier spectrum of Nova Auriga and of Nova Persei immediately after maximum; dark reversals of h and K lines give velocity of five kilometers recession."

Seven excellent photographs of the spectrum of Nova Geminorum No. 2 were taken at Harvard on March 13 and the same number on March 14. A marked change has occurred in the spectrum, the photographs on the first date showing only dark lines, while the hydrogen lines Hβ, Hγ, Hδ and He have well marked bright lines on the edge of greater wave length, on the second date. These last photographs closely resemble those of Nova Persei No. 2, on February 24, 1901. The bright lines seen with the slit spectroscope at Ann Arbor may have been too narrow on March 13, to show with an objective prism.

The brightness of the star has increased, and was about 3.5 magn. on March 14.

EDWARD C. PICKERING.

Astronomical Bulletin No. 488.
Harvard College Observatory,
Cambridge, Mass., Mar. 15, 1912.

Nova Geminorum.—The new star (Nova Geminorum) discovered by Enebo is increasing in brilliancy. It was approximately $\frac{3}{10}$ of a magnitude brighter last night than it was on Wednesday night. At $10^h\ 45^m$, 75th meridian time last night (March 14) it was less than $\frac{1}{10}$ of a magnitude fainter than θ Geminorum. Harvard Observatory reports spectrum of "F five type."

α Orionis normal and = to β Orionis.

F. E. SEAGRAVE.

Mr. F. E. Seagrave writes also on March 16: "Nova Geminorum down to $5^m.3$ at 8 o'clock C.S.T. The star is slightly red tonight." Again on March 17: "Nova $5^m.2$ at 7:15-7:45 tonight and decidedly red in color."

Enebo's Nova.—A letter received at this Observatory from Professor Frost, states that a photograph of Enebo's Nova, taken on the evening of March 15, shows that "The bright lines of hydrogen are very broad and there are many other bright bands and dark lines throughout the spectrum. The bright H and K, at about their normal positions, are strong and broad and are crossed by very sharp, dark lines. The helium lines λ 4923 and λ 5016, are strong, both bright and dark. Helium λ 4472 is not conspicuous, but probably present."

The following telegram, dated March 19, has been received from Dr. W. F. King of the Ottawa Observatory.

"Spectrum Nova Geminorum by Plaskett March eighteen seven tenths, numerous bright bands, maxima to red, and several narrow absorption lines, calcium, magnesium, iron. Velocity of recession about seventeen kilometers, magnitude about five and a half."

EDWARD C. PICKERING.

Astronomical Bulletin No. 490.
Harvard College Observatory.
Cambridge, Mass., March 20, 1912.

The History of the New Star, Nova Geminorum No. 2, is given below. Results obtained at Harvard are indicated by the letter (H).

Sunday, March 10. Nova not visible on a plate showing stars of magnitude 11.5 (H).

Monday, March 11. Nova well seen, magn. 5. (H).

Tuesday, March 12. Nova discovered by Enebo, at Dombaas, Norway, Magn. 4.

Wednesday, March 13. Cablegram received at Harvard, and distributed throughout America. In evening, Yerkes, and (H) find spectrum of class F 5, unlike other novae. Hydrogen lines strong and dark. University of Michigan finds hydrogen lines bright and recession 5 km., from dark lines. Magn. 3.8 (H).

Thursday, March 14, Yerkes and (H) find marked change in spectrum, hydrogen lines bright on edge of great wave length, like other Novae. Magn. 3.5 (H).

Friday, March 15, Photographs through thick clouds show nova faint magn. 5. Hydrogen lines very bright (H).

Saturday, March 16, Magn. 6, spectrum like normal nova spectrum. Nebular lines first seen. A star of magnitude 14 in place of Nova on several early plates.

EDWARD C. PICKERING.

Astronomical Bulletin No. 489.
Harvard College Observatory,
Cambridge, Mass., Mar. 17, 1912.

COMET AND ASTEROID NOTES.

The comets now in the sky are all too faint for observation by amateurs.

Ephemeris of Comet 1911 f (Quenisset).

[From Astronomische Nachrichten 4559.]

1912		α			δ		log r	log Δ	Mag.
		h	m	s	°	′			m
Apr.	5	8	44	42	−62	40.1	0.3958	0.3001	12.5
	7		39	57	61	37.4			
	9		35	52	60	35.7	0.4045	0.3139	12.6
	11		32	21	59	35.2			
	13		29	22	58	35.9	0.4131	0.3280	12.7
	15		26	51	57	38.0			
	17		24	45	56	41.6	0.4215	0.3423	12.8
	19		23	0	55	47.0			
	21		21	35	54	54.1	0.4296	0.3568	12.9
	23		20	27	54	2.9			
	25		19	34	53	13.5	0.4376	0.3713	13.0
	27		18	55	52	25.9			
	29		18	29	51	40.1	0.4454	0.3857	13.2
May	1		18	13	50	56.0			
	3		18	8	50	13.7	0.4530	0.4000	13.3
	5		18	12	49	33.1			
	7		18	24	48	54.2	0.4604	0.4141	13.4
	9		18	44	48	17.0			
	11		19	10	47	41.4	0.4677	0.4280	13.5
	13		19	43	47	7.4			
	15	8	20	22	−46	35.0	0.4748	0.4416	13.6

New Elements of Comet 1911 *f* (Quenisset.)—In *A. N.* 4559 Mr. M. Ebell gives the following new elements of comet 1911 *f*, corrected by means of observations made at Santiago, Chile, on January 18 and 19.

$T = 1911$ Nov. 12.34931 Berlin mean time
$\omega = 122° 01' 12''.3$
$\Omega = 35 14 08.2$ } 1911.0
$i = 108 07 06 .6$
$\log q = 9.896356$

Ephemeris of 1909 JA (Ekard.)

1912	* α (1912) h m s	* δ (1912) ° ′ ″	log Δ	log r
Apr. 1.5	12 26 45.91	−18 26 06.3	0.364587	0.517618
6.5	12 22 40.33	17 47 02.2	0.362661	0.516302
11.5	12 18 42.57	17 05 23.6	0.362121	0.514954
16.5	12 14 58.33	16 22 00.6	0.362952	0.513578
21.5	12 11 32.74	15 37 44.7	0.365117	0.512176
26.5	12 08 30.32	14 53 32.0	0.368516	0.510742
May 1.5	12 05 54.31	14 10 10.5	0.373038	0.509278
6.5	12 03 47.03	13 28 22.7	0.378559	0.507782
11.5	12 02 10.32	12 48 47.2	0.384953	0.506258
16.5	12 01 05.21	12 11 55.7	0.392085	0.504704
21.5	12 00 32.28	11 38 14.5	0.399814	0.503116
26.5	12 00 31.32	11 06 32.5	0.408965	0.501500
31.5	12 01 01.42	−10 41 29.9	0.416519	0.499852

* Corrected for aberration.

SETH NICHOLSON.
ALMA M. STOTTS.

Drake University, Des Moines, Iowa.

COMMUNICATIONS QUESTIONS AND ANSWERS.

[This department is designed especially for the use of amateurs. Beginners are invited to send in their puzzling questions. The editors will try to see that answers are given to reasonable questions, but will not hold themselves responsible for the correctness of the views expressed in the communications which may find place here. All communications should be brief.]

Canopus.—Some text books on astronomy published in the United States, make the broad statement, that Canopus, the principal star in Argo, is never visible in the United States, the star being too far south.

The position of Canopus is given in the *American Ephemeris* as R.A. $6^h\ 21^m$ Decl. $-52°\ 38'$. Its distance from the south pole is therefore $37°\ 22'$. Chattanooga, Tenn., is in Lat. $+35°\ 4'$; whence we can peep towards the south pole within that many degrees and minutes; in other words the south pole has dropped just $35°\ 4'$ below the theoretical south horizon for an observer in Chattanooga. Deducting this amount fram Canopus' polar distance leaves $2°\ 18'$, which is the height this star Canopus shows above the horizon in our city. From my south windows I look into Lookout valley and there, over Forest Hill Cemetery and the eastern slope of Lookout Mountain, I watch for Canopus every year; for twenty-five years, in December, January and February, with never flagging interest.

The horizon, not being generally perfectly clear and limpid, the seeing of Canopus is really more an atmospheric test from my observation point.

As Canopus will be the conspicuous south polar star in some 12000 years, when Vega will have assumed the place of the north star, its history has a peculiar fascination for the beholder of this faintly scintillating gem.

In its grand cosmic pendulum swings, of some 27000 years of periods, what organic and inorganic evolutionary changes has this far distant orb witnessed? Does it behold our little world and its so-called Lords of creation, ready to fly at each others throat today, and actually doing it—does Canopus behold us today any wiser than when it beheld the prehistoric monsters devouring each other in the struggle for existence, just a few of its mighty pendulum beats ago?

What fools these mortals be! War—What for? Ask George R. Kirkpatrick of West La Fayette, Ohio.

HERMAN FRITZ.

Chattanooga, March 7, 1912.

Another Observing Section.—We have not as yet in our society an Observing Section for the study of aurora borealis, the zodiacal light and the gegenschein, because I have not considered that we have enough members in the society who are observers of these phenomena to warrant the formation of a separate section for their study. However, if there are enough observers outside of the S. P. A. who observe these phenomena and who would be willing to join our society, I would be willing to form an Observing Section in the S. P. A. for the Study of the Aurora Borealis, the Zodiacal Light and the Gegenschein, which these observers could join, (and all members of the S. P. A. who care to), and work together for the accumulation of data and systematic records concerning the phenomena. In this way, it is altogether probable that results of some scientific value could be acquired much more rapidly than by a lot of observers working alone and absolutely independently. After a sufficient number of persons had been gotten together for the formation of this proposed section, a director could be chosen from among them and could be placed at the head of the work.

FREDERICK C. LEONARD.

Occultation of Antares.—I would like to give you my experience in February, with a telescope of very small aperture. I got up from bed with the intention of observing Schaumasse's comet, and the moment I left the house I saw there was soon to be an occultation of Antares (α Scorpii) by the moon. I had never witnessed a real brilliant star occulted and so I awaited this one with great eagerness. I was in hopes that the moon would pull up to Antares before daylight, but it didnt. The occultation came off at 8:15 A.M. Feb. 11, (E. S. time). At this time the sun was well above the horizon, and shining brightly. The only telescope I had at home was a hand glass of 1⅝-in. aperture. I had made a little wooden stand to steady it on, and as the moon kept bearing down closer, I watched all the more intensely. And, sure enough, I saw the star occulted in bright sunshine with a telescope of only 1⅝-inch aperture.

The star was always plainly visible, in reality more readily visible than the surface of the moon.

My purpose in reporting this is to show those who are beginning to take an interest in astronomy, that large telescopes are not at all necessary to witness an occultation in bright sunshine.

WM. H. CASSELL.

Wytheville, Va. Feb. 28, 1911.

Magnetic Disturbance March 1.—A terrestrial magnetic disturbance occurred on March 1. The magnetic needle was disturbed before noon and at 2:05 p. m. moved to 6° west and stood there for four minutes. Later it moved to 7° west and remained there for some time; at 3:38 fell to 0°; 3:43 moved to 20° east and, quieting down, stood at 20° east for a minute; 3:45 swung to 14° east and came to rest at 9° east; 3:50 fell to 0°; 5:03 moved to 10° east; 5:10 5° east; 6 p. m. 7° east, increasing to 9° east; 7 p.m. 7° east. From 7 to 10 p.m. the needle moved slowly four times between 7° and 9° east, requiring about 45 minutes to each move.

The above degrees are reckoned from the magnetic north, which is 6° 45 east of geographical north.

JUDSON W. BRUSH.

A Visit to the U. S. Naval Observatory.—Your readers may be interested in a short account of a recent visit it was my privilege to make to the Naval Observatory at Washington, D. C.

It is comparatively simple matter to secure a look at the various scientific instruments connected with this institution, including a peep through the 12-inch equatorial on the usual visitors night—but it is not every visitor who may secure the unusual privilege of a look through the great 26-inch equatorial, and the enjoyment of actually handling this wonderful instrument with his own hands.

This it was my fortune to do on the night of February 23. In the first place it should be understood that the present location of the observatory on Georgetown heights, which, although it seems out of the way, is really only twenty minutes by trolley from the Treasury building. The spot seems to be particularly well chosen for permanency. It is well elevated, the offices, observatory itself and all the outbuildings, being actually located in a park enclosure, which overlooks the city of Washington, and commands a fair view of the surrounding country.

In the afternoon I spent some time looking at the transit instruments, telescopes and library; also the time clocks and timing instruments and the electrical attachments which drop the time balls in seventeen different cities at each day noon; and then I was fortunate enough to arrange for a return after nightfall, through the courtesy of the superintendent, Capt. Jayne, U. S. N., to whom I presented a letter of introduction from Mr. W. W. Dinwiddie, who had formerly spent seven years as one of the government astronomers at this observatory.

It happened to be a grand night for seeing. The moon hung low in the west at the time of my arrival at 8:30, and as it was only five days old, it became a fine object for observing without being so bright as to spoil star work. This was naturally the first thing to observe. So after raising the floor, which by touching a lever noiselessly rises or falls to the required level, and swinging the great dome around with another delicate touch, we found the bright section of the moon in the field. We first tried a power of 400. This brought the craters out in bold relief. In fact the definition was quite startling. Unfortunately however, the illuminated portion, at this age of the moon, presented no special features, and besides, the sun's rays were nearly vertical, illuminating the craters all around, with none of the striking shadow effects that may be seen at later stages. The noticeable feature was the size of such craters as were visible, compared with their appearance in an ordinary

telescope, and the suggestion of nearness that was conveyed, also the feeling that one saw every scratch or elevation that existed. The most startling sensation came from noting the dark limb, which on this night was wonderfully clear, showing distinctly the outlines of the craters and seas, and then most wonderful of all, the entire rim or terminator of the dark disk showed the wavy outlines of the mountain and valleys which were thrown, as if in silhouette, against the darkness beyond.

We next tried Saturn. This planet was quite near the moon at this time and really too low for good observation. The lowest power the observatory could produce was 140, but this was too high for satisfaction, with the planet so near the horizon, and the result was disappointing. I have seen this planet with my five-inch equatorial to much greater advantage many times. This sounds strange but it is quite true.

Then we turned on the Pleiades, but with 140 power only one star at a time could be fielded. Alcyone appeared a blazing sun, dazzling and brilliant, and there were the three companions, widely separated. Here was where a power of say 40, would have worked wonders. I had quite hoped to see some wisp of the nebulous matter in which all the stars are enmeshed but this was impossible with so high a power.

Sirius was a great sight. The colored brilliancy of this great sun quite fulfilled all expectations. The ebullition of color seemed to steady down into actual flames of fiery red and purple, clearly defined and steady. Then we started a hunt for the companion and finally located it after a long and careful search, just in the outer circle of flame, to the right of the primary as we were looking at it. This of course is an object only visible in the most powerful glasses on account of its proximity to the primary, although it is really estimated as magnitude 10.

Orion was the next attraction. Here anticipation was keenest. First the Great Nebula. A power of 140 was of course not the best for observing this object and the results were disappointing, and yet there was compensation. Many minute stars were visible in the nebulous haze impossible to detect in smaller glasses. They seemed to be in pairs and to be related to the nebulous matter all about them. In and about the trapezium were one or two points of light quite new to a small telescope observer. The fifth and sixth stars were plainly visible. The fifth looked like a companion of the smallest of the customary four. A bright point of light in the outer section of the fishes' mouth was rather startling. In the midst of this otherwise black hole shone a tiny star. The nebula itself seemed constructed of wave-like folds, shaded from bright to dark in irregular cloudy patterns. We then dropped down to Sigma. With a 5-inch this fourth magnitude star develops into eight beautiful points of light. There are two sets of stars some distance apart, but sweeping from top to bottom of these apparently closely associated suns with a 26-inch reveals numerous other points of light in the same vicinity, all sharing the unusual brightness and beauty that characterize the familiar ones of higher magnitude.

Our last object was the planet Neptune. Nothing spectacular about this except the wonder of beholding a clear round surface reflecting the sun's rays 2800 million miles away. In color it appeared ash gray; no markings whatever could be seen. Just alongside, in faithful attendance was the one lone satellite, a close companion of this far away "wanderer". It appeared as bright and well defined as a tenth magnitude star in a five-inch.

In conclusion I wish to say that such a rare treat marks an epoch in the life of an amateur astronomer. The courtesy shown me by Mr. Burton and Mr. Watt, assistant astronomers, will not soon be forgotten. My only disappointment was to find there were no low power eyepieces. Without these the real and spectacular glory of the starry heavens was greatly curtailed, notwithstanding the otherwise perfect and superb equipment of this great observatory.

S. C. HUNTER.

New Rochelle, N. Y. Mar. 1, 1912.

Astronomical Names in the Book of Job.—In the book of Job I have been struck, every time I have read it, with the knowledge which the writer of that oldest book in the bible seemed to have of the stars and constellations. But in an old pamphlet which lately fell into my hands it appears that the Greeks made out the ancient writer of the book a more learned man than he really was. I regret that I cannot give the name of the writer of the pamphlet, but the following is an extract from it:

"The English translation, following the Septuagint and the Vulgate,* gives to some extent a higher coloring to astronomical science in the time of Job than is strictly warranted by the facts in the case. As an exemplification of this, it may be observed that we are indebted for that brilliant galaxy of constellations, Pleiades, Arcturus and Orion, to the rich imagination of the Hellenistic translators, and not to the *ipsissima verba* of the Hebrew original. Thus we have in the Septuagint the following passage:

'Who is the maker of the Pleiades and Hesperus
And of Arcturus and the chambers of the south.'

In the Vulgate it is as follows:

'Who maketh Arcturus and Orion
And the Hyades, and the interior of the south.'

The above, says our author, should be translated thus:

Who maketh the blight (osh) and the cold (cesil)
The genial heat (cime) and the thick clouds of the south.'

"Here, we see, that the Vulgate differs from the Septuagint in the names of the supposed constellations; from which it is plain that they followed no certain system in translating them, but that they rendered them so by conjecture, taking the names of such as were more familiar to them.

HENRY WHITE.

NOTES FOR OBSERVERS.

Remember the occultation of Venus April 15 and the Solar Eclipse of April 17. For the data see our January and March numbers.

Rev. Charles E. Niles, of Seneca, Kans., has been appointed director of the Planetary and Lunar Section of the S. for P. A., to fill the vacancy resulting from Mr. Wilson's resignation.

* Septuagint—The Greek version of the old testament Scriptures supposed to have been made between the third and second centuries B. C. Vulgate—St. Jerome's Latin version of the Bible.

Monthly Report of the American Association of Variable Star Observers.—It is a pleasure to report that the Association is making splendid headway, as the increased number of observations clearly indicates. It is also gratifying to announce that Dr. Caroline E. Furness, Director of the Vassar College Observatory, Poughkeepsie, N. Y. and her assistant, Miss P. R. Sutton, are now coöperating with us, and their observations are included in this report.

The value of this clearing-house system of observations continues to make itself manifest. Many mistakes of misidentification are corrected, and the reports enable those participating to see what progress they are making. In addition to this the reports afford a means whereby each one can plot the light curves of a great many of these interesting stars.

Although 074922 U Geminorum has been under constant observation by quite a number of observers during the past month, it has thus far failed to make its sudden rise. In all probability this rise will occur within the next month, and the field should be observed whenever the opportunity presents itself.

A maximum of 170215 R Ophiuchi, approximating the seventh magnitude, was observed by three observers during the third week of February, which agrees very well with Hartwig's calculated date of maximum Feb. 19.

A minimum of 123961 S Ursae Majoris, calculated by Hartwig to occur February 26th, was observed about that date by several of our observers, their observations being well in accord.

The observations of Hind's "crimson star," *045514* R Leporis, are noteworthy. Klein says of this star:—"The period is 436 days but with great irregularity." Our observations during the past month bear out to some degree this statement. Hartwig calculates a minimum for July 21, and although the star if regular would now be on the wane, an inspection of the observations of four observers shows that the variable was brighter the last two weeks of February than during the four weeks previous. Owing to the wonderfully ruddy hue of R Leporis its light is extremely difficult to estimate correctly.

The report shows that the variables 072708 S Canis Minoris, 094211 R Leonis, and 103769 R Ursae Majoris, were exceptionally well observed. The observations are well in accord and show in many cases very close work on the part of observers widely separated, as for example, the observations of R Leonis on the night of February 29, by Miss Sutton in Poughkeepsie N. Y., Mr. Lacchini in Imola, Italy, and Mr. Olcott, in Norwich, Conn., with estimates of 8.5, 8.4, and 8.4 respectively.

An extremely interesting feature of the report is found in the early morning observations of Dr. Gray and Mr. Jacobs of that mysterious star 154428 R Cor. Bor. Taking Mr. Jacobs observations alone, the drop of 1.5 magnitudes in two weeks time, considering the star, would not seem very unusual, but evidently the drop was more sudden, for luckily Dr. Gray observed the star the morning of February 22, and found it bright, which shows that this precipitate fluctuation of 1.6 magnitudes occurred in two days time or less instead of two weeks. Such observations as these are the best evidence of the value of coöperation in this work, and make manifest its practical nature even to the uninterested and uninitiated. Surely in the observation of variable stars the amateur has a splendid opportunity to add his mite to the sum total of astrophysical knowledge.

The key to the abbreviations of the observers' names was published in the last report. Additional abbreviations are as follows:—Fu. indicating the observations made by Dr. Caroline E. Furness, Director of the Vassar College Observatory, Poughkeepsie, N. Y.; Su. those of Miss P. R. Sutton, assistant in said observatory.

The writer is indebted to those coöperating in this report for sending in their lists of observations so promptly, thereby greatly facilitating his work in preparing it for publication.

WILLIAM TYLER OLCOTT.
Corresponding Sec'y.

Norwich, Conn.
Mar. 10, 1912.

VARIABLE STAR OBSERVATIONS Feb. 10 to Mar. 10, 1912.

001726
T Andromedae

Mo.	Day	Est.	Obs
2	12	9.7	Y
	14	9.8	O
	28	10.5	Y

001755
T Cassiopeiae

Mo.	Day	Est.	Obs
2	13	11.4	J
	22	11.1	J
	23	11.2	J
	23	11.1	Y
3	1	10.6	Y
	7	10.9	J

001838
R Andromedae

Mo.	Day	Est.	Obs
2	10	7.3	V
	19	7.7	V
	23	7.9	Fu
	24	7.7	V

004047
U Cassiopeiae

Mo.	Day	Est.	Obs
2	12	9.9	Fu
	12	8.8	Y
3	1	10.5	Y

004132
RW Androm.

Mo.	Day	Est.	Obs
2	12	10.1	Fu
	13	10.8	J
	16	10.7	O
	22	10.8	J
	23	10.9	O

004533
RR Androm.

Mo.	Day	Est.	Obs
2	16	9.5	O

004958
W Cassiopeiae

Mo.	Day	Est.	Obs
2	13	8.8	J
	22	8.9	J
	23	8.9	J
3	7	8.9	J

011272
S Cassiopeiae

Mo.	Day	Est.	Obs
2	12	9.6	Fu
	13	9.7	J
	18	9.7	Ha
	22	9.9	J
	23	10.0	J

012502
R Piscium

Mo.	Day	Est.	Obs
2	10	8.6	S
	12	8.4	Y
	17	8.6	Y
	28	8.5	Y

013238
RU Androm.

Mo.	Day	Est.	Obs
2	13	12.6	J

013338
Y Androm.

Mo.	Day	Est.	Obs
2	13	9.5	J
	22	8.5	J
	23	8.4	J
3	7	8.8	J

014958
X Cassiopeiae

Mo.	Day	Est.	Obs
2	23	11.3	Y

021024
R Arietis

Mo.	Day	Est.	Obs
2	13	8.7	O
	19	8.2	O
	20	9.0	Su
	23	8.0	O
3	5	8.0	O
	7	8.8	Su

021143
W Andromeda

Mo.	Day	Est.	Obs
2	13	9.9	Su
	20	10.1	Su
3	5	10.6	Su

021403
o Ceti

Mo.	Day	Est.	Obs
2	12	9.1	L
	13	9.0	F
	14	9.0	O
	15	9.2	L
	16	8.8	G
	17	9.2	L
	18	9.2	Ha
	21	9.2	L
	23	9.0	O
	28	8.8	F
3	4	9.0	Ha

022000
R Ceti

Mo.	Day	Est.	Obs
2	19	8.6	G

022813
U Ceti

Mo.	Day	Est.	Obs
2	19	9.5	G

023133
R Triang

Mo.	Day	Est.	Obs
2	12	10.4	Y
	13	10.2	Su
	20	10.7	Su
	23	11.0	Y
3	5	11.5	Su

024356
W Persei

Mo.	Day	Est.	Obs
2	12	9.9	V
	19	9.9	V
	20	10.0	O
	24	9.3	V
3	5	10.0	O

030514
U Arietis

Mo.	Day	Est.	Obs
2	12	8.8	Y
	17	8.7	Y
3	1	8.7	Y

032043
Y Persei

Mo.	Day	Est.	Obs
2	20	9.6	Su
3	5	9.6	Su

035916
V Eridani

Mo.	Day	Est.	Obs
2	28	9.0	G

042209
R Tauri

Mo.	Day	Est.	Obs
2	20	10.4	Su
	29	10.6	Su

042215
W Tauri

Mo.	Day	Est.	Obs
2	17	11.1	Y
	20	11.4	O
	23	10.2	G
	28	10.0	G

043065
T Camelop.

Mo.	Day	Est.	Obs
2	12	9.0	Fu
	12	9.0	Y
	23	8.8	Y
3	1	8.9	Y

043274
X Camelop.

Mo.	Day	Est.	Obs
2	17	12.8	Y

045307
R Orionis

Mo.	Day	Est.	Obs
2	12	9.8	Y
	17	9.4	Y
	28	9.6	Y

045514
R Leporis

Mo.	Day	Est.	Obs
2	12	8.1	V
	13	7.0	F
	15	6.8	F
	16	7.6	G
	18	7.4	G
	20	7.0	O
	21	7.2	G
	23	7.6	V
	27	7.0	O
	28	7.2	F
	28	7.1	G
	29	7.7	V

050953
R Aurigae

Mo.	Day	Est.	Obs
2	23	12.6	Y

052034
S Aurigae

Mo.	Day	Est.	Obs
2	23	9.1	Y

053068
S Camelop.

Mo.	Day	Est.	Obs
2	12	8.1	Y
	12	8.7	Fu
	23	8.0	Y
3	1	8.1	Y

053531
U Aurigae

Mo.	Day	Est.	Obs
2	12	8.5	Y
	17	8.6	Y
	24	8.5	Y

054319
SU Tauri

Mo.	Day	Est.	Obs
2	28	9.5	Y

054920
U Orionis

Mo.	Day	Est.	Obs
2	12	11.5	Y
	17	11.5	Y

055353
Z Aurigae

Mo.	Day	Est.	Obs
2	12	10.7	Y
	28	10.6	Y
3	1	10.4	Y

060450
X Aurigae

Mo.	Day	Est.	Obs
3	5	9.4	Su

060547
SS Aurigae

Mo.	Day	Est.	Obs
2	23	11.4	Y

065355
R Lyncis

Mo.	Day	Est.	Obs
2	12	7.5	Y
	13	8.1	J
	22	8.4	J
	23	8.5	J

VARIABLE STAR OBSERVATIONS Feb. 10 to Mar. 10 1912—Continued.

070310
R Can. Min.

Mo.	Day	Est	Obs.
2	12	8.5	O
	15	8.9	V
	16	8.5	O
	18	7.2	G
	19	8.5	O
	23	8.8	V
	23	9.0	O
	29	8.8	V
3	5	9.0	O

072708
S Can. Min.

Mo.	Day	Est	Obs.
2	11	9.5	Ha
	12	9.7	L
	12	10.0	O
	12	9.5	S
	13	10.0	F
	14	9.5	O
	14	9.3	G
	15	9.5	L
	16	9.6	F
	17	9.5	Ha
	18	9.6	G
	19	9.5	O
	20	9.6	L
	22	9.4	L
	23	9.3	O
	27	8.9	G
	27	9.3	Ha
	28	9.5	F
	29	8.8	B
3	2	8.8	B
	4	9.0	Ha
	5	8.3	O

073508
U Can. Min.

Mo.	Day	Est	Obs.
2	27	11.2	G

081112
R Cancri

Mo.	Day	Est	Obs.
2	20	10.5	O
	26	10.5	O
3	5	10.5	O

082405
RT Hydrae

Mo.	Day	Est	Obs.
2	15	7.4	V
	20	7.6	O
	23	7.8	V
	29	7.5	V
3	5	8.0	O

085008
T Hydrae

Mo.	Day	Est	Obs.
2	20	8.6	O
3	5	9.3	O

085120
T Cancri

Mo.	Day	Est	Obs.
2	15	9.6	V
	20	9.3	G
	23	9.2	O
	24	9.5	V
3	5	9.4	O

090425
W Cancri

Mo.	Day	Est	Obs.
2	12	10.4	S
	13	10.7	Fu

093178
Y Draconis

Mo.	Day	Est	Obs.
2	12	10.4	Y
3	1	11.5	Y

092934
R Leo. Min.

Mo.	Day	Est	Obs.
2	20	9.0	O
	23	9.0	O
3	5	9.0	O

094211
R Leonis

Mo.	Day	Est	Obs.
2	11	8.9	Ha
	12	9.0	L
	15	8.7	L
	15	8.5	V
	17	8.2	Y
	18	8.6	Ha
	20	8.4	L
	20	8.5	Su
	22	8.6	G
	23	8.4	O
	23	8.1	V
	26	8.2	O
	27	8.2	Ha
	29	8.0	V
3	1	7.3	Y
	4	8.0	Ha
	5	8.0	O

095421
V Leonis

Mo.	Day	Est	Obs.
2	14	9.3	Su
3	7	9.0	Su

103769
R Urs. Maj.

Mo.	Day	Est	Obs.
2	11	9.8	Ha
	12	9.9	L
	12	10.2	Fu
	12	9.9	Y
	13	10.5	O
	13	10.1	J
	13	10.2	B
	14	10.0	L
	15	10.2	L
	16	10.6	L
	17	10.6	Ha
	17	10.5	L
	17	10.2	Y
	18	10.5	G
	20	10.6	L
	20	10.4	B
	21	10.9	L
	22	10.8	S
	22	11.0	L
	22	10.8	J
	23	10.9	J
	27	10.7	B
	28	11.0	Y
	28	11.0	F
3	5	10.8	O
	5	11.0	B
	7	11.2	J

105517
R Crateris

Mo.	Day	Est	Obs.
2	18	9.0	G

113439
RU Urs.Maj.

Mo.	Day	Est	Obs.
2	13	8.9	Fu
3	7	10.0	Fu

122532
T Can. Ven.

Mo.	Day	Est	Obs.
2	14	12.2	Fu

123160
T Urs. Maj.

Mo.	Day	Est	Obs.
2	11	10.6	Ha
	12	9.8	Y
	12	9.5	S
	13	9.4	Fu
	17	9.1	Y
	20	8.8	O
	23	8.7	J
	26	8.0	O
	29	8.2	J
3	1	8.0	Y
	5	8.1	S
	5	7.8	O

123961
S Urs. Maj.

Mo.	Day	Est	Obs.
2	12	11.2	Y
	12	11.1	L
	14	10.5	B
	20	10.9	B
	22	10.9	J
	23	10.9	J
	26	11.1	O
3	4	11.0	Ha
	5	10.2	B
	5	10.2	S

132422
R Hydrae

Mo.	Day	Est	Obs.
2	14	5.2	G
	22	5.5	G
	29	5 8	G
	29	6.0	F

141567
U Urs. Min.

Mo.	Day	Est	Obs.
2	10	12.0	J
	12	11.2	S
	13	10.9	Fu
	22	10.8	J
	23	10.8	J
	28	10.5	J
3	5	10.0	S
	7	10.2	J

141954
S Boötis

Mo.	Day	Est	Obs.
2	17	8.9	Ha
	22	9.4	J
	23	9.5	J
	29	9.8	J

142584
R Camelop

Mo.	Day	Est	Obs.
2	12	9.7	Fu
	12	9.5	O
	13	9.5	B
	13	9.7	J
	16	10.0	O
	19	9.9	G
	20	9.9	B
	22	10.2	J
	23	10.3	O
	23	10.2	J
	23	10.2	B
	28	10.6	B
3	5	10.7	B

142539
V Boötis

Mo.	Day	Est	Obs.
2	26	7.3	G

153378
S Urs. Min.

Mo.	Day	Est	Obs.
2	12	10.2	L
	13	9.5	Fu
	15	10.1	L
	16	10.1	L
	17	10.1	L
	20	10.2	L

154428
R Cor. Bor.

Mo.	Day	Est	Obs.
2	10	7.5	J
	22	7.4	G
	24	9.0	J

154536
X Cor. Bor.

Mo.	Day	Est	Obs.
	10	11.5	J
	24	12.6	J

155847
X Herculis

Mo.	Day	Est	Obs.
2	15	6.6	L
	20	6.4	L
	22	6.5	L

162119
U Herculis

Mo.	Day	Est	Obs.
2	15	8.4	G
	25	9.0	G

163172
R Urs. Min.

Mo.	Day	Est	Obs.
2	13	8.5	B
	16	8.5	B
	23	9.1	B
3	2	9.2	B

163266
R Draconis

Mo.	Day	Est	Obs.
2	10	9.1	J
	17	8.8	Y
	22	8.4	J
	22	8.3	S
	23	8.7	J
	29	7.9	J
3	1	7.6	Y
	5	7.5	S

164715
S Herculis

Mo.	Day	Est	Obs.
2	10	8.0	J
	24	8.4	J

170215
R Ophiuchi

Mo.	Day	Est	Obs.
2	10	7.1	J
	20	6.9	L
	21	6.9	L
	22	6.9	L
	24	7.0	J
	25	7.1	G
	26	7.1	G

180531
T Herculis

Mo.	Day	Est	Obs.
2	15	9.7	L
	18	10.4	G
	25	11.0	G

184205
R Scuti

Mo.	Day	Est	Obs.
2	26	6.7	G

193449
R Cygni

Mo.	Day	Est	Obs.
2	10	9.0	L
	11	9.1	L
	14	9.1	G
	15	9.1	L
	16	9.1	L
	17	9.4	L
	20	9.5	L
	21	9.8	L
	22	9.3	G
	24	9.6	Ha
	29	9.6	F
	29	9.4	G

VARIABLE STAR OBSERVATIONS Feb. 10 to Mar. 10, 1912—Continued.

194048
RT Cygni

Mo.	Day	Est.	Obs.
2	11	7.9	L
	14	8.1	G
	15	7.9	L
	16	7.9	L
	17	7.8	L
	20	7.8	L
	21	7.6	L
	22	7.6	L
	22	7.6	G
	29	7.3	G
	29	8.0	F

200938
RS Cygni

Mo.	Day	Est.	Obs.
2	24	8.7	J
	25	8.0	G

201647
U Cygni

Mo.	Day	Est.	Obs.
2	15	7.0	G
	24	7.5	J
	29	6.7	G

205923
R Vulpeculae

Mo.	Day	Est.	Obs.
2	24	8.2	J

210868
T Cephei

Mo.	Day	Est.	Obs.
2	12	10.5	L
	13	10.2	J
	15	10.7	L
	15	10.3	V

T Cephei

Mo.	Day	Est.	Obs.
	17	10.5	L
	18	10.5	Ha
	20	10.6	L
	21	9.9	G
	21	10.9	L
	22	10.3	J
	22	10.9	L

213044
W Cygni

Mo.	Day	Est.	Obs.
2	15	5.7	L
	17	5.9	L
	22	6.0	L
	16	6.2	G

213678
S Cephei

Mo.	Day	Est.	Obs.
2	12	8.5	O
	13	8.9	J
	16	8.5	O
	19	8.6	G
	22	8.7	S
	22	8.9	J
	23	8.9	J

213843
SS Cygni

Mo.	Day	Est.	Obs.
2	10	12.0	J
	12	11.7	Y
	13	11.9	J
	24	11.5	J

230759
V Cassiopeiae

Mo.	Day	Est.	Obs.
2	12	8.3	V
	13	8.0	J
	13	8.5	F
	16	8.6	O
	22	8.7	J
	23	8.8	V
	23	8.8	J
	24	8.6	G
	29	8.6	V

235939
SV Androm.

Mo.	Day	Est.	Obs.
2	12	9.5	Y
	15	9.5	Fu
	17	9.4	Y
	28	8.8	Y

GENERAL NOTES.

Monument to Dr. J. Janssen.—It is proposed to erect a monument to Dr. J. Janssen, eminent for his work in astrophysics. The officers of the organizing committee are President, H. Poincaré; vice-presidents, B. Baillaud and G. Bigourdan; secretary, P. Puiseux; treasurer, H. Dehérain, Bibliothécaire à l'Institut, Paris, to whom contributions should be sent (*Science* 1912 Mar. 8).

Dr. R. T. Whittaker F.R.S., royal astronomer of Ireland, has been appointed professor of mathematics in the University of Edinburgh.

Portrait of Professor Langley.—A portrait of Samuel Pierpont Langley, Director of the Allegheny Observatory from 1867 to 1889, has recently been installed in the observatory. It is the work of F. Carl Smith, and the gift of the late Miss Jennie Smith.

F. SCHLESINGER.

Allegheny Observatory,
Allegheny Pa.

Mr. E. Neville Nevill, director of the Natal Government Observatory, Durban, is retiring from office, and will in future live in England (*Science*, 1912 March 8).

Professor Lewis Boss, director of the Dudley Observatory has been quite ill for some time. It is to be hoped that his recovery may be speedy, that he may complete the very important researches on the motions of the stars, in which he was engaged when taken ill.

Mr. Joseph H. Elgie author of "The Night Skies of a Year" writes that his book has been very successful and that he will shortly bring out a popular edition.

Dr. F. W. Dyson, F. R. S., has been elected president of the Royal Astronomical Society.

Hypothetical Parallaxes of the Brighter Stars of the A Type.— In the *Monthly Notices* of the R.A.S. for January 1912 Mr. H. C. Plummer of Oxford, England, gives some interesting results of computations which he has made, based upon the radial velocities of the brighter A type stars observed at the Lick Observatory. Assuming that these stars are all moving parallel to the plane of the Milky Way, Mr. Plummer finds it possible to calculate the parallaxes of the individual stars from their radial velocities and proper motions and an adopted velocity of the sun. For the last he assumes 16.8km. toward the apex R.A. 270° and Decl. +30°. This gives a component +6.5km. for the sun normal to the Milky Way. Assuming that the component of motion of each star toward the plane of the Milky Way is due wholly to the sun's motion, the parallaxes of the star can be determined from this component, and thus the actual velocity parallel to the plane of the Milky Way in any direction can be determined from the other component.

Mr. Plummer finds from 172 stars

Negative parallaxes	38
Excessive velocities	8
Excessive parallaxes	2
Reasonable cases	124

The number of stars with parallaxes less than 0″.1 is 111. This large proportion, more than half of the stars employed in the investigation, with small parallaxes is favorable to the correctness of the assumption made, that the stars tend to move in the plane of the Milky Way.

In studying the possibility of groups of stars moving in a common direction, Mr. Plummer finds that 70 of the 172 stars may be considered as falling into four groups, whose convergents are represented by the coördinates A and D (right ascension and declination) and their resultant velocities relative to the sun by R in the following table:—

Group	No. of stars	R km.	A °	D °
I	22	9.7	65.2	− 24.4
II	19	37.9	87.0	+ 7.3
III	16	21.6	106.0	− 52.9
IV	13	10.0	317.2	− 23.6

The convergent of the second group agrees within 10° with that of the Taurus group discovered by Professor Lewis Boss a few years ago. It would thus appear that the Taurus stream is not a mere localized cluster, but contains members which are scattered over the whole sky.

The writer of this note (H. C. Wilson) has been working on a similar problem during the past year with a different list of stars and has reached somewhat the same conclusion. A considerable proportion of the stars of large proper motion have their apices of motion within 30° of the apex of the Taurus stream, which is in the vicinity of $\alpha = 90°$ $\delta = +30°$. The convergent is the direction of the resultant of the stars own motion and the relative motion which is conferred upon it by the motion of the sun. An interesting point which comes out of a brief calculation is that, although the convergents of Plummer's groups I and IV are 108° apart, their apices of motion, on

the supposition that the sun is moving at the rate of 20km. per second toward the point 270° + 30°, are within 20° of each other and both are within 30° of the solar apex. The velocity of group I comes out 12 km and that of group IV 25km. Again the apex for group IV is within less than 20° of that of Sirius and the Ursa Major stream and the velocity is almost the same.

Recent Progress in Astronomy.—Mr. Paul Stroobant, of the Royal Observatory at Brussels, has issued a very useful pamphlet entitled "Les progrès récents de l'astronomie". It is an extract of 132 pages from the "Annuaire astronomique de l'observatoire royal de Belgique, and deals with the progress made in the various branches of astronomy in the year 1910. It contains many things which it is convenient for the astronomer to have at hand, collected in one pamphlet.

Parallaxes of Double Stars.—In *A. N.* 4543 Mr. E. Hertzsprung of Potsdam, Germany, gives the results of a study which he has made of the "Double Stars with quite notable orbital motion", in which he has used a novel method of calculating the parallaxes of these stars. Starting out with those stars whose parallaxes have already been obtained by other methods, he calculates, from their observed orbital motion in seconds of arc, what their parallaxes would be if their velocities were parabolic and the sum of the masses in each case were equal to the mass of the sun. Such a parallax he calls a minimum "hypothetical" parallax. Dividing the observed parallaxes by the computed minimum "hypothetical" parallaxes he finds the ratio to be fairly constant and nearly equal to 2; so that "By multiplying the minimum hypothetical parallaxes by about two, one obtains the true parallaxes with a mean error of about ± 0.14 in their logarithms, or about ±⅓ of their values." This rule may then be applied in cases where the parallax is otherwise unknown, but the orbital motion is fairly well determined.

The writer starts with the formulae

$$a^3 = P^2 (M_1 + M_2)$$
$$V' = 2\pi a/P$$

in which a is the semimajor axis, P is the period, M_1 and M_2 are the masses of the two components of the double stars, all expressed in units of the corresponding quantities in the earth's orbit; V^1 is the velocity in a circular orbit in units of the radius of the earth's orbit per year.

Combining the two equations gives

$$aV^2 = 4\pi^2 (M_1 + M_2)$$

Since for parabolic velocity $V = V' \sqrt{2}$, it follows that for the largest velocity that can be assumed

$$RV^2 = 8\pi^2 (M_1 + M_2),$$

where R is the radius vector.

If R and V be expressed in seconds of arc instead of units of the earth's orbit, then

$$RV^2/p^5 = 8\pi^2 (M_1 + M_2),$$

and, since the actual velocity is less than parabolic, and the radius vector can only be fore-shortened by projection, if we call the observed projections of the radius vector and velocity in a double star orbit r and v, it follows that

$$p^3 > rv^2/[8\pi^2(M_1 + M_2)] = p^4_{min} \qquad (1)$$

where p_{min} is the lower limit sought for the parallax.

If we designate by p_h the socalled "hypothetical" parallax, which results from assuming $M_1 + M_2 = \odot$ (the mass of the sun), the lower limit of this hypothetical parallax becomes:

$$p^2_{h,\,min} = \tfrac{1}{8}\,\pi^{-3}.\ r\ v^2. \qquad (2)$$

The results obtained from 25 doubles whose parallax p has been determined by other methods are given in table I.

TABLE I.

Burnham's Gen. Cat.	Star	Orbital motion ″	in years	Mean distance ″	$p_{h,min.}$ ″	p ″	$\frac{p}{p_{h,min.}}$
—	Gro. 34	3.0	49	39	0.123	0.281	2.3
1854	Σ 443	0.75	69	8.7	0.024	0.055	2.3
4815	Σ 1280	2.8	74	6.	0.048	0.099	2.1
4972	Σ 1321	6.	72	19.4	0.120	0.162	1.3
5706	Σ 1516AC	1.0	44	7.7	0.037	0.088	2.4
6842	ζ Urs.Maj.	0.7	70	14.3	0.027	0.043	1.6
7060	Sh 190	7.	69	15.	0.125	0.172	1.4
7905	36A Oph.	3.4	83	4.5	0.046	0.305	6.6
8798	Σ 2398	7.	73	16.	0.123	0.292	2.4
9560	16 *c* Cygni	1.3	73	38.	0.054	0.158	2.9
10702	61 Cygni	13.8	75	18.5	0.190	0.311	1.6
11761	Krueger60	3.9	16	3.2	0.134	0.256	1.9
12740	OΣ 547	1.8	29	4.3	0.059	0.138	2.3
426	η Cassiop.	0.23	1	6.2	0.163	0.200	1.2
2109	o^2 Eridani	1.75	12.9	2.43	0.083	0.174	2.1
2134	55 Tauri	0.30	9.5	0.25	0.015	0.025	1.7
3596	α Can.maj.	0.59	1	8.8	0.339	0.376	1.1
4187	α Can.min.	2.4	4.9	5.0	0.246	0.324	1.3
5734	ξ Urs.maj.	1.8	12.0	2.03	0.084	0.179	2.1
6243	γ Virginis	1.07	21.3	5.58	0.056	0.058	1.0
—	α Centauri	0.48	1	19 3	0.385	0.759	2.0
7717	ζ Herculis	0.53	2.1	0.69	0.082	0.142	1.7
8162	μ' Herculis	0.12	1	1.14	0.061	0.106	1.7
8340	70 Oph.	0.45	1	1.8	0 167	0.168	1.0
10846	τ Cygni	0.57	7.0	0.71	0.039	0.128	3.3

For these stars the value of the ratio $p/p_{h,min}$ comes out nearly 2.

$$\log\,(p/p_{h,min}) = 0.27 \pm 0.14$$

In table II the results are given for a number of doubles whose parallax has not been otherwise determined, and the writer has also computed the "absolute" magnitude of these stars, i. e. their magnitude reduced to the distance where the parallax would be 1″. For this reduction the formula is $m_a = m + 5 \log p$. Hertzsprung has used $p_{h,min}$ instead of p but as the logarithm of the factor 2 is only 0.3 the resulting magnitudes are probably correct within a half magnitude in most cases, on the assumption that the sum of the masses of the two components is equal to the mass of the sun.

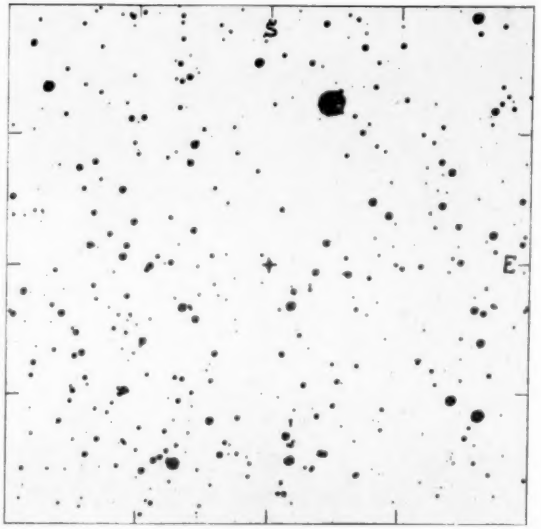
From computations it appears that about a third of these stars are really as bright as or brighter than Sirius, whose "absolute" magnitude calculated in this manner is about − 4.0.

The last column of table II gives the type of spectrum of the principal component of the double. It will be noticed that stars of the B type are found only in the first third of the list (among the brighter and more distant stars) while those of the K type predominate in the last third of the list (among the nearer and fainter stars).

TABLE II

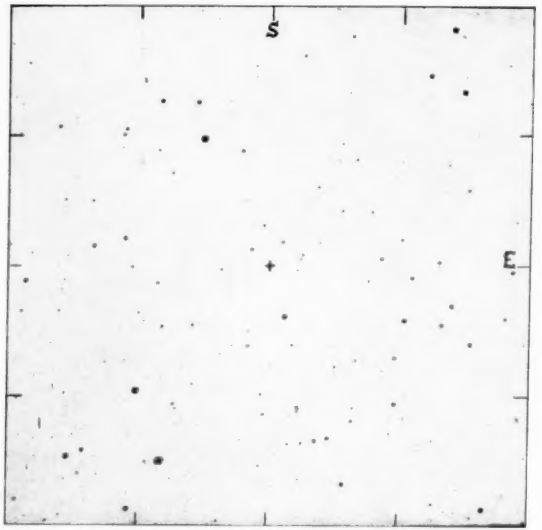
Burnham's Gen.Cat.	Innes Ref.	Cat.	Star	Combined magnitude	$2p_{h,min}$	$m + 5\log p_{h,min}$	Spectrum
	h			m	″	m	
2902	5	69	ζ Orionis	1.91	0.016	−8.60	B0
6993			ε Bootis	2.59	0.021	−7.35	K,A
2883	5	64	σ Orionis	3.78	0.014	−7.05	B0
7914			α Herculis	3.31	0.026	−6.14	Mb
600			φ Androm.	4.28	0.017	−6.04	B8
5388			γ Leonis	2.30	0.048	−5.80	K0
6482			ζ Urs. Maj.	2.17	0.054	−5.68	Ap, A2
10533			λ Cygni	4.47	0.021	−5.49	B5
4122			α Gemin.	1.58	0.079	−5.47	A0
	12	68	β Muscæ	3.26	0.037	−5.41	B3
	11	55	β Hydræ	4.40	0.026	−5.04	B9
5652			α Urs Maj.	1.95	0.081	−5.02	K0
1512			ε Arietis	4.64	0.024	−4.94	A2
	15	35	γ Circini	4.54	0.028	−4.74	B5p
993			γ Arietis	4.04	0.038	−4.38	Ap
9605			δ Cygni	2.97	0.070	−4.32	A0
1262			ι Cassiop.	4.59	0.035	−4.23	A5
9713			ε Draconis	5.15	0.028	−4.14	B5
	1	1	β Phoenicis	3.35	0.067	−4.03	K0
1061			α Piscium	3.94	0.051	−4.03	A2p
5765			ι Leonis	4.03	0.055	−3.77	F5
8783			ε^1 Lyræ	4.68	0.041	−3.77	A3
8785			ε^2 Lyræ	4.50	0.046	−3.69	A5
	23	3	θ Gruis	4.35	0.051	−3.65	F5
3970			δ Gemin	3.51	0.076	−3.61	F0
11743	22	24	ζ Aquarii	3.75	0.069	−3.55	F5
4866			ι Urs. Maj.	3.12	0.123	−2.97	A5
6788			κ Bootis	4.44	0.067	−2.94	A5
10509			γ Delphini	4.12	0.077	−2.94	G5
	1	35	τ Sculptor.	5.68	0.039	−2.90	A8
1612	3	8	12 Eridani	3.95	0.096	−2.65	F8
11483			ξ Cephei	4.40	0.093	−2.26	A8
7905	17	21	36 A Oph.	4.56	0.092	−2.13	K
7878			μ Draconis	5.06	0.075	−2.07	F5
	1	14	κ Tucanæ	4.96	0.081	−2.00	F8
	1	46	ε Sculptor	5.39	0.070	−1.91	F
1393			θ Persei	4.22	0.134	−1.63	G0
9137			Cygni 6B	5.97	0.079	−1.07	K
9560			16 *c* Cygni	5.56	0.108	−0.79	F
7514			κ Herculis	5.02	0.139	−0.77	K
11715	22	23	53 *f* Aquarii	5.70	0.114	−0.51	F8
1854			Σ 443	7.83	0.048	−0.27	G5
6367	12	95	48 Virgin.	6.51	0.099	−0.03	F
4815			Σ 1280	6.8	0.096	+0.2	K
	17	31	Lac. 7194	5.58	0.192	+0.48	K
5706			Σ 1516 AC	7.69	0.074	+0.53	
7060	14	105	Sh 190	5.50	0.250	+0.99	Kp
	1	13	Lac. 353	7.5	0.100	+1.0	
1179	2	8	Lal. 4219	7.92	0.091	+1.20	
10732			61 Cygni	5.12	0.398	+1.61	K5
4972			Σ 1321	6.7	0 240	+2.1	Ma
12740			OΣ 547	8.62	0.118	+2.47	K5
			Gro. 34	7.66	0.246	+3.10	Ma
8798			Σ 2398	8.86	0.246	+4.30	K
11761			Krueger 60	9.43	0.268	+5.07	

PLATE VIII.



110. 1904. V Lacertæ.

$\alpha = 22^h42^m44^s$, $\delta = +\ 55°33'{\cdot}4$ (1855·0)
$\alpha = 22\ 44\ 33$, $\delta = +\ 55\ 47{\cdot}6$ (1900·0)
$8\frac{1}{2}^m - 9\frac{1}{2}^m$



44. 1905. RY Andromedæ.

$\alpha = 23^h13^m41^s$, $\delta = +\ 38°49'{\cdot}5$ (1855·0)
$\alpha = 23\ 15\ \ 50$, $\delta = +\ 39\ \ 4{\cdot}3$ (1900·0)
$9^m - < 13^m$

CHARTS OF V LACERTÆ AND RY ANDROMEDÆ.

The Observatory at Moscow.—Volume V of the Annals of the Observatory of Moscow has as its frontispiece the beautiful photograph of the observatory, which we have placed at the beginning of this number of POPULAR ASTRONOMY. The volume contains a number of papers giving the results of invertigations by Professor W. Ceraski, the Director, and Messrs. P. Sternberg and S. Blazko. From a series of photometric measurements in 1903-04 Professor Ceraski found that 112 days before inferior conjunction the sun gave 1,483,000,000 times as much light as Venus. By means of comparisons between Venus aud Regulus (α Leonis) he found that the sun gave 242,400,000,000 times as much light as Regulus. Taking the magnitude of Regulus as 1.57 (as given in Pub. Astr. Obs. Potsdam, Band VIII p. 235) the magnitude of the sun comes out

$$-26.89.$$

Measures in 1905 give

By comparison with Polaris	($2^m.15$)	$\odot = -26.41$ (4 deter.)
" " "	Procyon (0 .56)	$\odot = -26.57$ (4 ")
" " "	Sirius (−1 .09)	$\odot = -26.57$ (1 ")

From all of these results Professor Ceraski adopts as the weighted mean

$$\odot = -26.50 \text{ mag.}$$

Two appendices to the volume give 56 photographic charts of the regions about variable stars which have been discovered at the Observatory of Moscow. These charts are of uniform size, 80′ square, and appear to have been accurately reproduced. They should be very valuable to variable star observers. We give reproductions of two of these charts in Plate VIII, accompanying this note.

The Spectrum and Orbit of β Scorpii.—In Vol. II No. 14 of the Publications of the Allegheny Observatory Mr. Zaccheus Daniel and Professor Frank Schlesinger give the results of a determination of the orbit of this spectroscopic binary. The binary character of β Scorpii was discovered in 1903 by Dr. V. M. Slipher, from twelve spectrograms secured at the Lowell Observatory, and independently by Mr. W. S. Adams at the Yerkes Observatory from four plates taken with the Bruce Spectrograph. In 1910, Dr. Slipher announced the interesting fact that this star is one of those whose spectra show sharp H and K lines which do not share in the periodic shift of the other lines. The spectrum is of the strong helium type (B_1) with broad and diffuse lines, except in the case of the H and K lines. The spectrum of the secondary component is faintly visible on some of the plates, and appears to be identical with that of the primary component.

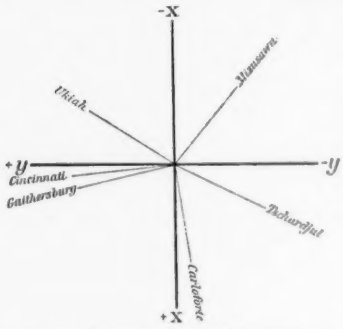
The elements found are as follows:

$P = 6.8283$ days
$\mu = 52°7218$
$e = 0.270$
$\omega = 20° 09$
$T =$ Julian Day 2,419,163.923 G.M.T.
$\gamma = -11.0$ km.

	Primary	Secondary
K =	125.66 km.	197 km.
A =	157.54 km.	147 km.
B =	93.80 km.	247 km.
$a \sin i$ =	11,360,000 km.	17.800,000 km.
$m \sin^3 i$ =	13.0 ⊙	8.3 ⊙

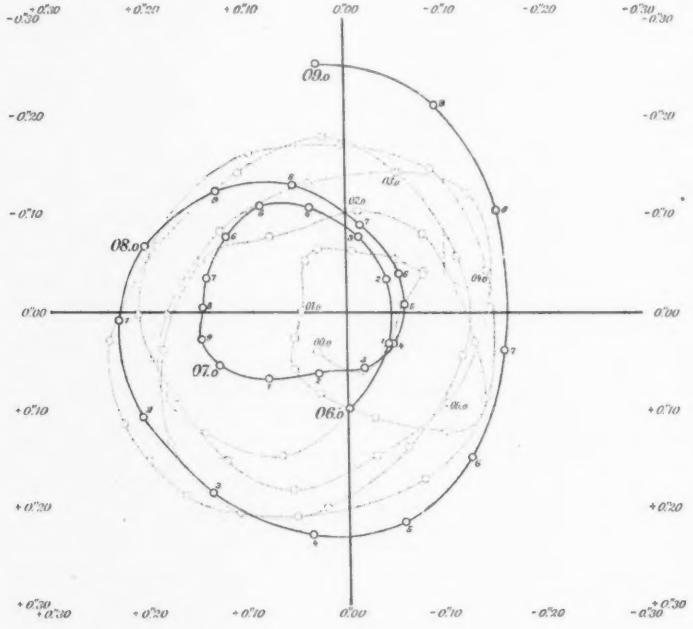
$$\text{Ratio of masses} = \frac{m_2}{m_1} = 0.64$$

The Movement of the North Pole of the Earth's Axis.—The fourth volume of "Resultate des International Breitendendienstes", which has just come to hand, gives the results of the discussion by Th. Albrecht and B. Wanach of the observations made at the six latitude stations on the parallel of latitude +39° 8′, during the years 1906-08. The stations are: Mizusawa, Japan; Tschardjui, Central Asia; Carloforte, Italy; Gaithersburg, Maryland; Cincinnati, Ohio; and Ukiah, California. Their distribution in longitude is shown in Figure 1.



DISTRIBUTION OF THE STATIONS.

In figure 2 the light dotted line shows the path of the pole from 1900.0 and to 1906.0 and the dark heavy line the path during the three years 1906-08. It will be seen that the amplitude of the movement was at minimum in 1900 and 1906, and that it was at maximum in 1908.



PATH OF THE NORTH POLE OF THE EARTH'S AXIS.

The Discovery of the South Pole appears to be an accomplished fact, so that now the geography of the earth is almost as completely known as the areography of Mars. Captain Roald Amundsen reached the south pole in December 1911 and remained there three days to verify his observations for position. According to an editorial in the Scientific American for March 16; "Amundsen seems to have collected enough evidence to substantiate the theory that the great chain of mountains, which extends almost uninterruptedly from Alaska to Patagonia, finds its continuation in a ridge connecting Victoria Land and King Edward VII Land, and which, in honor of his queen, he has named 'Queen Maude's Range'. The ice barrier, which had proved for a century and a half a formidable obstacle to Antarctic exploration, is found to terminate in a bay, lying between the southeast mountain range running from South Victoria Land and a range which is probably a continuation of the King Edward the VII Land and which extends in a southwesterly direction."

No less than four other expeditions were in the Antarctic regions at the same time and it is quite possible that some of them may have also reached the pole.

"Amundsen seems to have been helped by exceptionally favorable weather conditions. To be sure, there were storms, but not those frightful hurricanes which thwarted Shackleton. It was cold, so cold that the dogs suffered visibly, yet the average temperature was no lower than that in many an inhabited part of Canada. Amundsen himself states that part of his journey was much like a pleasure trip—'excellent ground, fine sledging and an even temperature.' The glaciers and crevasses made detours necessary, yet despite them progress was remarkably rapid. The party climbed up 2,000 to 5,000 feet in a day.

"Thoughout much of his journey Amundsen covered entirely new ground. Therefore he will bring back absolutely new information of Antarctic geography."

The Annual Meeting of the Astronomical Society of Pittsburg was held at the Allegheny Observatory on March 1. The Executive Committee elected for the ensuing year (the only officers of the society) are Professor F. C. Jordan, Dr. Walther Riddle and Mr. W. R. Ludewig.

F. SCHLESINGER.

Allegheny Observatory.
Allegheny, Pa.

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